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NATURE

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" To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, MAY 5, 1892.

TEXT-BOOKS OF PSYCHOLOGY.

The Human Mind: a Text-book of Psychology. By James Sully, M.A., LL.D. Two Vols. (London: Longmans, 1892.)

Hand-book of Psychology: Feeling and Will. By James Mark Baldwin, M.A., Ph.D. (London: Macmillan, 1891.)

Text-book of Psychology. By William James. (London: Macmillan, 1892.)

IN his treatise on the "Human Mind," Mr. Sully has not attempted to supplant, but rather to supplement, his own admirable "Outlines of Psychology." The method in the two works is the same, and the arrangement of the subject-matter, though it differs slightly in some details, is, on the whole, essentially and in principle similar. A chapter has been added on the physical basis of mental life, dealing briefly with the nervous system and with neuro-psychical correlations. But the author wisely refers his readers to text-books of physiology or to manuals of physiological psychology for a full treatment of these matters. He also gives an adequate account of the recent experimental researches on the nature and conditions of some of the simpler responsive activities, but is not blind to the difficulties and uncertainties of this so-called experimental psychology.

It is well known that Mr. Sully lays great stress on the genetic method in psychology.

> "It is evident," he says, "that we require a knowledge of these psychical elements [reached by analysis] and of the laws of their combination, in order to account for the complex products of the mature human consciousness. Now, the perfect account of a thing means the history of that thing from its first crude to its completed form. When the psychologist has succeeded by analysis, aided by objective observation and hypothesis, in obtaining the requisite data, he proceeds to reconstruct the course of psychical development."

From the standpoint of biology and evolution, this genetic aspect of psychology is of especial importance, and we cannot be too grateful to Mr. Sully for his able, clear-headed, and, on the whole, cautious presentation of this view of the matter. But it is one which, as Mr. Sully himself well knows, is of peculiar difficulty. Few of us remember anything of the genesis of our modes of psychological procedure in the early days of our life; and when we do remember scraps here and there, we are only too apt to interpret them in terms of our adult procedure, with which we are so much more familiar. It is, moreover, well nigh impossible for the psychologist to realize the nature of the psychical processes of the child, so that infant psychology is a field wherein we may suppose much and can prove little. Mr. Sully again and again appeals to the supposititious child.

> "The child, for example," he says, "begins to note that some varieties of living things, *e.g.* flies or birds, die. He then compares these results, and, extracting the common relation, finds his way to the more comprehensive generalization, 'All animals die.' Later on he compares this result with what he has observed of flowering and other plants, and so reaches the yet higher and more abstract generalization, 'All living things die.'"

Of course there may be a child here and there who proceeds, or, in the absence of all instruction in the matter, might proceed, thus. But children and uneducated persons very rarely reach a general and universal concept, properly so called. The child notes that its pets and other animals die or are killed: this begets a stronger and stronger expectation that other animals will likewise die or be killed some day; and the expectation may rise to practical certainty without anything like a universal concept taking even vague and indefinite shape in the mind. We therefore question the statement that "by induction the child reaches a large number of general or universal judgments," though it is unquestionable that he may have a large number of expectations which the logician may cast in universal form. He may even state them in universal form himself, and say, "Animals die," "Apples have pips," the language he uses being here, as in so many cases, in advance of his conceptions.

In the discussion of the development of the moral sentiment, the distinctively moral feeling is perhaps hardly differentiated with sufficient care from the merely prudential. The prudential does not pass up into the moral on the same line of development; but the prudential and the moral are separate and sometimes widely divergent lines of development. It is sometimes said that the prudential is self-centred while the moral is social. But is not what is socially right different from what is socially prudent? Or, in other words, is not morality something other than social prudence? Remorse for wrong has a different psychological quality from regret for error, no matter what the social implications of the error may be. Mr. Sully does not seem to have sufficiently brought out this distinction in his account of the genesis of the moral sense.

But though there may be room for some difference of opinion as to the exact course of genetic development by which our more complex and more highly evolved psychological states have been reached, there can be no question that Mr. Sully's painstaking and thoughtful discussion of their possible or probable mode of evolution is and will long remain of real and sterling value. No living writer has paid more attention to this important aspect of psychology.

There is one more point on which we may comment before we pass on to Prof. Baldwin's work. It is the doctrine of residual fusion.

> "The simplest form of assimilation," we read, "is to be found in that process by which a present sensation (or sensation complex) is re-apprehended or 'recognized' as something familiar. . . . What takes place here is the calling up by a present sensation of the trace or residuum of a past sensation (or sensations), which trace merges in or coalesces with the new sensation, being discernible only through the aspect of familiarity which it imparts to the sensation. . . . We have to conceive of the nervous process somewhat after this manner. A given central element or cluster of elements is re-excited to a functional activity similar to that of a previous excitation. The residuum of this previous activity or surviving 'physiological disposition' somehow combines with and modifies the new activity; which blending of nervous processes has for its psychical correlative the peculiar mode of consciousness known as recognition, sense of familiarity, or identification. Here, however, our physiological psychology seems to be more than usually conjectural."

And again—

> "In recognition the percept and the image are fused, the presence of the latter being indicated merely in the peculiar appearance of familiarity which the percept assumes."

This so-called "fusion" of the percept and the image seems to us an awkward figure by which to describe the facts. The sequence of states of consciousness in the case of (*a*) practical or perceptual, and (*b*) reflective or conceptual recognition, seems to be briefly as follows. Suppose I recognize a man, A, as one whom I have met before, say at a dinner party. Then I have first a percept $\overset{A}{q\,.\,n\,.\,z\,.\,y}$, where A is the individual in question in the focus of consciousness, and $q\,n\,z\,y$ the "fringe" generated by his present surroundings, more or less out of focus. This percept is immediately followed by the image $\overset{A}{s\,.\,r\,.\,t\,.\,b}$, where A appears amid different surroundings. This constitutes practical or perceptual recognition. In reflective or conceptual recognition there follows an act of introspection (or retrospection), whereby the common central element in the two states of consciousness is explicitly identified. There is no fusion in either case, except in so far as sequent states of consciousness have a central or focal element which is identifiable. If we simply recognize A as someone we have met somewhere, we do not remember where, there is associated with the focal image, A, an indefinite fringe of pastness serving to differentiate it from the percept with its fringe of present surroundings; and if, on the other hand, we recognize A as a quite familiar person whom we have seen again and again amid all sorts of surroundings, there is a fringe which we can only describe as involving both pastness and frequency. In the case of the animal or the child, recognition presumably does not pass beyond the practical stage—that is to say, a percept A with this fringe is followed by an image *A* with that fringe. Reflective recognition, involving retrospection and a comparison of the two images (*A* with this fringe and *A* with that fringe) and the identification of the element common to both, is a product of conceptual processes of later genesis.

In conclusion, it is sufficient to say that by his treatise on the human mind Mr. Sully fully sustains his reputation as a psychologist.

In his volume on "Feeling and Will," Prof. Baldwin has completed the survey of the mind begun in his "Senses and Intellect."

The first three chapters contain an adequate physiological introduction. There is, however, one statement which seems to us awkward if not misleading. After briefly noting the views that have been suggested as to the relation of consciousness to the so-called nervous conditions, Prof. Baldwin says:—

> "It has become apparent that nervous activity, considered by itself alone, does not bring us into the range of psychological science. However we may decide the inquiry as to whether such activity is ever entirely free from consciousness, it is yet true that it may be quite outside of what is called the individual's consciousness. . . . In other words, the greater part of our ordinary nervous reactions are not above the threshold of our conscious lives. So we reach a distinction between sentience as a nervous property and sentience as a conscious phenomenon, between *sentience and sensibility*. Sensibility is synonymous with the usual consciousness of the individual's experience, and sentience is the nervous function which may or may not be accompanied by consciousness or inner aspect in general. . . . The transition from simple sentience to the full consciousness is through a stage of subconscious modification."

With no desire to be hypercritical, this does not seem to us altogether satisfactory. Sentience is spoken of as "the *nervous function* which may or may not be *accompanied by* consciousness." The words we have italicised seem to imply that sentience belongs to the physical, not the psychical order of existence. If so, the "transition from simple sentience to full consciousness" is a transition from the physical to the psychical order, and consciousness becomes a mode of energy. We do not think that this is the author's meaning; but in that case it would be well so to define sentience as to clearly show that though it may not rise to the level of consciousness, it is none the less of the conscious or psychical order.

When we leave the physiological and enter the psychical field, appeal is constantly made to the "principle of apperception" or "selective synthesis." But does not the author go somewhat beyond what is justified by our very imperfect knowledge of the facts of cerebral physiology when he asserts that "after we enter consciousness, we find a principle of apperception to which there is no analogy in physiological integration"? Elsewhere he says: "Now, as a fact, the great principle of mental organization, selective synthesis, finds no apparent counterpart in physics." In direct opposition to this view, we venture to contend that nothing is more remarkable than the parallelism (if it be no more) of selective synthesis in the physical and the psychical spheres. In the physical world this is best seen in the formation of chemical compounds and their segregation in crystalline form. In the psychical world it is seen in the so-called principle of apperception. This is, however, only the expression in the conceptual sphere of a principle which, stripped of all metaphysical implications, must be extended to the whole range of psychical life, as a general law of psychogenesis. In the organic world (at any rate the animal world) the two principles (if two they be) meet. And if, notwithstanding the splendid work done in bionomics, through the application of "natural selection" to the elucidation of the problem, we have not yet reached a scientific expression of selective synthesis in organic life and growth, this is no proof that there is no such selective synthesis.

In accordance with the general principles he adopts, Prof. Baldwin divides feeling into the two great classes of (1) sensuous feeling, and (2) ideal feeling. Sensuous feeling relates to the bodily functions. "Sensuous pleasure," says the author, "may be defined as the conscious effect of that which makes for the continuance of the bodily life or its advancement; and sensuous pain, the conscious effect of that which makes for the decline of the bodily life or its limitation." Ideal feelings, on the other hand, are the modifications of sensibility which accompany the exercise of the apperceptive function. Ideal pleasure may be defined as "the conscious effect of that which makes for the continuance of the apperceptive life or its advancement; and ideal pain, the conscious effect of that which makes for the decline of the apperceptive life or its limitation." But though sensuous feeling can have no reference to the conceptual or apperceptive life, ideal feeling has reference (however much we affect to despise or ignore the mere body) to physical as well as intellectual well-being. Hence Prof. Baldwin concludes "that ideal tone (pleasure or pain) refers to personal well-being as a whole."

We must pass over without comment an important and interesting discussion of "reality and belief," which is worthy of careful consideration, and may proceed to note the somewhat unusual sense in which the author uses the word "ideals."

> "Ideals," he says, "are not mental constructions at all: if once constructed they would no longer be ideals: which only means that what we call ideals are emotional in their nature, expressing the drift or felt outcome of the constructive process, not any actual attainment of it. If my ideal man, for example, were an intellectual construction, I would be able to describe him. . . . Ideals, therefore, are the forms which we feel our conceptions would take if we were able to realize in them a satisfying degree of unity, harmony, significance, and universality."

This seems to us somewhat strained. It is a description of theoretically ideal ideals which have been emptied of all practical value. There are assuredly practical ideals which, though unattainable, can be definitely realized as intellectual constructions permeated with emotional tone. And it is these practical ideals which are influential on conduct.

The distinction between subjective and objective ends in ethics is carefully drawn. Subjective ends are the felt and more or less definitely realized motives of the voluntary process. They alone have psychological value as the immediate determinants of conduct. Objective ends are a matter of cognition.

> "Even though it were granted that all voluntary action arose and survived by exclusive reference to pleasure or to self-realization, yet it would be a patent fallacy to say that the only voluntary end is either of them—that consciousness has all along been versed in our biology or our speculative ethics, and has aimed to fulfil the one or the other. Consciousness has no inkling of the *δύναμις* of Aristotle, or the *connatus* of Spinoza, or the *Trieb* of Wundt and Schneider; of the 'strife [*sic*] for existence' of Spencer, the theoretic 'reverence for law' of Kant, the 'self-realization' of Green, or the dialectical 'becoming' of Hegel. Let us discover these things if we may, but do not let us say that a man is not moral unless he has a realizing sense of them."

We have left ourselves no space to deal with Prof. Baldwin's discussion of the phenomena of the will. We do not by any means agree with all that he says thereon, but it is worthy of careful consideration.

Prof. James's "Text-book of Psychology" is a rearranged abridgment of his larger "Principles," with the addition of some description of the senses and sense-organs. We have so recently (NATURE, vol. xliii. p. 506) expressed our opinion of the value of the larger work, that we can, without injustice to Prof. James, afford to be brief in our notice of this abridgment, merely selecting the chapter on "Instinct" on which to offer a few comments.

Every organism comes into the world with an innate capacity to perform, more or less definitely, certain activities under the appropriate environing circumstances. Of these activities, a certain number which are (1) complex in character, and (2) performed (*a*) in a definite way, (*b*) without foresight of the end to be attained, (*c*) with no previous education in the performance, and (*d*) uniformly by all normal individuals of the species concerned, are now by pretty common consent described as instinctive. Clearly such instinctive actions are the outcome of the innate capacity of the animal which performs them; but they are a peculiar and special manifestation of this innate capacity: they have definite and clearly assignable characteristics. Now no one can question that man comes into the world with a relatively enormous store of innate capacity, and that he has innate tendencies to perform half a hundred particular activities. And yet he has but few instincts. He leads a life of hesitation and choice, an intelligent life. To say with Prof. James that this is "not because he has no instincts—rather because he has so many that they block each other's path"? is practically to abandon the position which has been painfully and slowly gained by those who have thought and written on instinct. Instinct is a definite and special manifestation of innate tendency: here the innate tendency is not manifested in this definite and special way, but is thwarted. To call both manifestation and non-manifestation alike instinct is, in our view, a retrograde step, which we regret that a psychologist of Prof. James's insight and influence should have taken.

We cannot, however, leave the book with a note of dissent; for we find far more in this text-book to agree with than to dissent from. Whether we agree or dissent, we always find Prof. James full of stimulating thought; and we advise all who are interested in psychology to read at least the chapters on "Habit," "The Stream of Consciousness," and "The Self," if they read no more.

C. Ll. M.

DYNAMICS OF ROTATION.

Dynamics of Rotation: an Elementary Introduction to Rigid Dynamics. By A. M. Worthington. Pp. 155. (London: Longmans, Green, and Co., 1892.)

Spinning Tops. By John Perry. Pp. 136. (London: Society for Promoting Christian Knowledge, 1890.)

THE persistence of spinning tops and of running bicycles in rearing themselves erect are common examples of a wide class of dynamical phenomena which are influenced or governed by the presence of rapidly rotating parts, and which have a prominent place in all departments of physical science, from the relations of the systems of the stars down to molecular actions.

In formal treatises on abstract dynamics we are accustomed to find the properties of freely rotating systems relegated to an advanced part of the development of the subject, and expounded with all the powerful help which mathematical analysis can afford. If we are to have a complete theory of the circumstances which determine the stability and transformations of rotational motions, this analytical aid is none too extensive. But there is another mode of approaching a physical subject, which consists in learning from observation and properly varied experiment what are the phenomena that are persistent and stable, and then applying known dynamical principles to the elucidation of the properties of the motions thus known in fact to exist—a problem which need not in those simpler cases which are fundamental require any great amount of analytical knowledge.

As an additional reason for the customary abstract development of dynamics, there may perhaps be counted the historical fact that the questions that were of paramount importance when dynamical principles concerning extended systems of bodies were being evolved, related to the orbital and axial motions of the heavenly bodies, and their reconciliation with the law of universal gravitation. The absence of frictional resistances, and the long duration and delicacy of astronomical observations, had led to a minute knowledge of the motions of the solar system, which taxed all the resources of Clairaut, D'Alembert, Laplace, and Lagrange, to verify and explain.

Many of the dynamical principles which are now treated as elementary and fundamental were thus come upon in special analytical investigations relating to physical astronomy. It was, for example, in this way that the principle of the conservation of angular momentum for the solar system was discovered by Laplace, and then generalized to a system with any kind of internal connections which is not subject to forces from outside it. How far a general principle of this kind, when divested of its analytical dress, enables us to see into the general causes of things is well known. A striking illustration is the *aperçu* of Prof. James Thomson, that when once the trade winds have been explained as a consequence of the earth's rotation, they involve of necessity the existence also of anti-trades or south-west winds in the temperate zone; for if the trades blew by themselves their friction against the earth would always be acting round in the same direction, and therefore would tend to stop the earth's rotation, not by wholly destroying its motion, but by transferring its angular momentum undiminished to the atmosphere, where it would continually accumulate. This simple remark thus shows that the trades blowing to the equator must be compensated by anti-trades blowing from it; and therefore also explains the existence of a region of high barometer between them. It will also occur to memory how much J. Purser, W. Thomson, and specially G. H. Darwin, have established in the tidal evolution of the earth-moon system, by studying the possibilities of development that are allowed subject to the conservation of its angular momentum and the degradation of its energy.

It has been reserved for our own half-century to bring out the wealth of general dynamical ideas that is contained in the magnificent analytical presentation by Lagrange of the results of the application of the laws of motion to systems of bodies, the number of variables or co-ordinates being of necessity (for analytical purposes) restricted to the number of degrees of freedom, and everything turning out to be expressible in terms of one fundamental function—the energy of the system. It will be apparent, on looking through Prof. Cayley's Reports on Dynamics to the British Association, how much the progress of this department of abstract dynamics was indebted to the necessities of astronomy. That science presented a problem which was in one sense quite definite and precise, on account of the smallness of the planetary masses, but which nevertheless required a minute explanation of the perturbations to which the planetary bodies are subjected owing to their mutual actions. The methods which proved comprehensive and efficient for this purpose also showed themselves, when they were examined from a more general standpoint, to reveal principles of a far-reaching character, that applied to dynamical systems however complicated. The final stage of analytical development was reached when the keen perception of Sir W. R. Hamilton saw that the whole subject could be removed from special considerations of space and time, and attached to the purely analytical treatment of a single varying action function; and the commentary of Jacobi showed precisely how to pass from this general differential analysis to the solutions of special dynamical questions.

At the present time there seems to be no danger of the interruption of progress by too close an adherence to the calculus. The fact is, that nearly all the problems of the numerical calculation of perturbations which were urgent at the beginning of the century, in order to bind the solar system to the scheme of universal gravitation, have now been satisfactorily disposed of. There is no longer the same need for the greatest intellectual power to set itself to put right some periodic or secular inequality, which requires all the battery of analysis that is available, and often more. New ground has been broken since then, and there is the great array of the physical sciences, all struggling to become purely dynamical, but all hampered in this by the fact that the dynamical machinery, the phenomena of matter and motion, on which they depend, are to a great extent concealed from direct observation or exploration. Under such circumstances the method of progress is to carefully cherish, and reduce into a scheme such as will appeal directly to the understanding, all the general principles which have become evolved in the course of dynamical investigations relating to problems of which the data are thoroughly known; and to use them as a key for the dynamical interpretation of more recondite phenomena by the aid of analogies and the numerical verification of their results. The mode of progress has thus veered from the analytical to the synthetical, from the powerful inverse analysis of Laplace and Lagrange to methods more akin to those which were worked by Newton.

It may be stated as a general rule that the relations most directly intelligible and most flexible in this kind of application are properties of constancy, or of maximum and minimum, such as belong in fact to the more obvious features of the continuous growth of pure quantity. The conservation of energy, of linear momentum, of angular momentum, the minimum energy criterion of equilibrium, of steady motion, the maximum and minimum energy criteria which determine the motion following the application of impulses specified either by their actual amounts or by the velocities they produce at their points of application—these may all be cited in illustration. The crown of the edifice will be Maupertuis's principle of Least Action, whose range of exact application, initiated for dynamics by Lagrange and Hamilton, is now being extended into all departments of physics, thus working out an answer to the question—To what extent can the succession of phenomena in inanimate Nature from instant to instant be treated as governed by a principle analogous to that of minimum expenditure of effort in the sentient world?

The phrase from instant to instant is essential, for a path may—as, for example, a great circle on a sphere—be the shortest between two points within a given range of each other, but may cease to have that property when the starting point and the final point are taken too far apart on it. In a similar way, in statics, a certain region of stability is determined around each position of equilibrium, such that, if the system is not disturbed beyond that region, it will not leave the neighbourhood; while, in dynamics of a particle, such a region is more vaguely determined around each orbit by the nature of the enveloping curves or surfaces of the neighbouring orbits.

From the point of view of the direct appreciation of dynamical ideas, the small books at the head of this article form a very welcome addition to the ordinary text-books. The work of Prof. Perry, popular lecture though it be—and one feels constrained, from the confident style, to believe that his audience of operatives understood every word of it—leads on the reader by vivid illustration into contact with the boldest flights of dynamical speculation. After the ordinary effects of spin have been copiously illustrated, we are taken into a world in which matter has two kinds of inertia; and, by aid of a chain of balanced gyrostats, we learn that a cord cannot ever transmit motion straight on without also twiddling about. It is fortunate for those of us who have to follow or teach mechanical pursuits that this new species of matter is not often heard of, and is only called up in relation to such unnoticeable, and practically insignificant, phenomena as rotation of the plane of vibration of light waves. The relations of ordinary mass to gravitation, and such like are sometimes intricate enough things to discuss; the introduction of a second kind of mass, and that of a vector character, might lead to despair.

The great pioneer in this field of work, of eliciting the concealed dynamical mechanism of tangible phenomena, is, of course, Lord Kelvin, by whom nearly all our knowledge on the subject has been originated, at any rate in its present exact form. Prof. Perry's book is all the more welcome and suggestive, in that it claims to be chiefly a connected account of what he has learned at first hand from the teaching of Lord Kelvin; an account which has possibly not been published before by anyone, at least in a consecutive form.

Prof. Worthington, after an elementary quantitative introduction to dynamical principles, has gone over the part of dynamics of rotation which relates to a single spinning solid, in the manner of a text-book with numerical illustrations; and there is no doubt that a mastery of his explanations would be a very valuable part of the outfit of a student of physics. J. L.

THE MAMMALIA OF BRITISH INDIA.

The Fauna of British India, including Ceylon and Burma. Published under the authority of the Secretary of State for India in Council. Mammalia. Part II. By W. T. Blanford, F.R.S. (London: Taylor and Francis, 1891.)

IN our issue of September 27, 1888, we had the pleasure of bringing before the notice of our readers the first part of Mr. Blanford's valuable monograph on the Mammals of British India. The second part, completing this important work, has lately been published. The delay, as is explained in the preface, has been caused by the necessity Mr. Blanford has been under of spending much time in editing the five volumes of the same series that have appeared since the first part of the present work was issued. His labours in this respect have been increased by two unfortunate and unforeseen circumstances—the lamented death of Mr. Francis Day, and the expiration of the leave of Mr. E. W. Oates, in both cases before the termination of the portions of the work, on fishes and birds respectively, upon which they were engaged, and the completion of which has thus fallen upon Mr. Blanford himself.

In the preface of the present part, the origin of the series to which it belongs is thus related:—

"The need for new and revised descriptive works had, for some years before 1881, been felt and discussed amongst naturalists in India, but the attention of the Government was, I believe, first called to the matter by a memorial dated September 15 of that year, prepared by Mr. P. L. Sclater, the well-known Secretary of the Zoological Society, signed by Mr. Charles Darwin, Sir J. Hooker, Prof. Huxley, Sir J. Lubbock, Prof. W. H. Flower, and by Mr. Sclater himself, and presented to the Secretary of State for India. This memorial recommended the preparation of a series of hand-books of Indian zoology, and my appointment as editor. It is scarcely necessary to add that to the recommendation of men so highly respected and well known in the world of science, the publication of the present 'Fauna of British India' is greatly due, and that Mr. Sclater is entitled to the thanks of all interested in the zoology of India for the important part he took in the transaction."

We are also glad to learn from the same source that the series of works on the fauna of British India will not be confined to the Vertebrata, the preparation of three volumes on Moths by Mr. G. F. Hampson having been commenced. We trust that these will be followed by others dealing with those groups of which sufficient material is available, and for which authors may be forthcoming capable of treating them in a manner worthy to be placed by the side of those already issued.

The second part of the Mammalia contains the orders Chiroptera, Rodentia, Ungulata, Cetacea, Sirenia, and Edentata. It is fully equal to its predecessor in careful selection of the material which is most likely to be useful and attractive to those readers for whom the work is chiefly intended. The descriptions, geographical distribution, and accounts of the habits of the various species can be thoroughly relied upon. Nomenclature is always a thorny subject in zoology, and though Mr. Blanford is usually most careful and judicious in his work in this department, we cannot agree with him in substituting the specific name of *maximus* for the time-honoured and universally used *Elephas indicus*. The inconvenience of changing the name by which such a familiar animal is designated in thousands of books and museums, is so great that it can only be justified by some more imperious necessity than appears to exist in the present case. That *maximus* was applied by Linnæus to both the then known species, and that it is incorrect and misleading (the other existing, and many of the extinct, species being as large as, or larger than, the Indian elephant) are sufficient reasons, in our judgment, for leaving the name in the oblivion in which it has slept for nearly a century. Moreover, if *indicus* be rejected, the claims of Blumenbach's *asiaticus* cannot be overlooked.

The illustrations of the present part are far superior to those of the former one, and show a marked advance in the art of process-printing directly from the artists' drawings, without the intervention of the wood-cutter. Many of those by Mr. P. Smit, though printed from blocks in the text, have all the softness and delicacy of the finest specimens of lithography, and add greatly to the attractiveness of this valuable work.

W. H. F.

OUR BOOK SHELF.

Tanganyika: Eleven Years in Central Africa. By Edward Coode Hore, Master Mariner. (London: Edward Stanford, 1892.)

MR. HORE was for eleven years a member of the Central African Mission established at Lake Tanganyika by the London Missionary Society, his special task being to undertake all the work that could be most effectually accomplished by one who had the knowledge and experience of a master mariner. In the present book he gives an account of his labours. The narrative contains many elements of interest, and will be read with pleasure by all who like to think of devoted courage in the service of great moral ideas. Mr. Hore became very familiar with Lake Tanganyika, which he surveyed in the first instance on board a native boat. Afterwards the British supporters of the mission enabled him to build two vessels in which he had opportunities of doing his work in a style worthy of its magnitude and importance. Of the physical characteristics of the lake and the surrounding regions he gives an unpretending but sound and sometimes picturesque account. He has also much to say about the natives, whose confidence and good-will he seems to have had a rare power of winning. He has a very favourable opinion of their capacities, and knows of no good reason why they should ever be treated by Europeans otherwise than with kindness and patience.

Beginner's Guide to Photography. By a Fellow of the Chemical Society. (London: Perken, Son, and Rayment, 1892.)

THIS very cheap and useful little guide has now reached its fourth edition. The reader is led through all the phases of manipulation that at first sight seem so bewildering, but which with clear explanations are soon rendered more simple and eventually mastered. All questions relating to "How to buy a Camera, and how to use it," may be said to be here fully answered, and by following the instructions an amateur may be saved from much disappointment and expense. The explanations throughout the book are both clear and explicit, and the omission of such technicalities as might confuse rather than enlighten a reader will be found distinctly advantageous.

Quain's Elements of Anatomy. Edited by E. A. Schäfer, F.R.S., and G. D. Thane. In Three Vols. Vol. II., Part 2. By Prof. Thane. Tenth Edition. (London: Longmans, Green, and Co., 1892.)

IT is necessary here only to record the fact that the publishers have issued the second part of the second volume of this magnificent edition of Quain's standard work. The editor is Prof. Thane, and the subjects dealt with are arthrology, myology, and angeiology. There are no fewer than 255 illustrations, many of which are coloured.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Zebra's Stripes.

ALMOST every writer who treats of the colours of animals refers to Galton's observations that in the bright starlight of an African night zebras are practically invisible even at a short distance; but there can be no doubt that their peculiar striped appearance is also of great protective value in broad daylight. On a recent zebra hunt near Cradock, in which I took part, several members of our party commented on the difficulties of seeing zebras even at moderate distances, although there was nothing to hide them, the black and white stripes blending so completely that the animals assume a dull brown appearance quite in harmony with the general colour of the locality in which they are found, and in which, for instance, Rooi Rehbok (*Pelea capreolata*) is also well protected on account of its peculiar brownish coat. A member of our party, who on another occasion gave proof that he is possessed of excellent eyesight, and who has frequently hunted in similar localities, saw a zebra which was wounded in one of the front legs at a distance of about 400 yards, and strange to say he mistook it for a big baboon. In a letter which I received from him a few days ago, he said, "It galloped like a baboon from me, and I could only see that the colour was greyish-brown. At about 500 yards from me it ran on to a little krantz, and mounting the highest rock, drew its body together just as a baboon does when its four feet are all together on the summit of a little rock." His remark as to the greyish-brown colour of the animal is the more valuable, as I believe this gentleman, Mr. Wrench, A.R.M. of Cradock, is quite unprejudiced. In my own letter to him, which drew forth these remarks, I had only asked him for the distance at which he saw the zebra, and I did not ask him how it was that he mistook a black and white zebra for a brown baboon on a perfectly clear South African day. My own observations also confirm that the stripes of the zebra are of protective value. Riding along a slope I suddenly saw four zebras within 100 yards above me. They were galloping down the hill, but stopped when they caught sight of me. As soon as they stopped I saw their stripes pretty distinctly. After I had fired and wounded one of them, they started again galloping down the hill round me in a semicircle at a distance of about 70 yards. All this time they presented a dull brown appearance, no stripes being visible, although I had my attention fixed on this point. They disappeared beyond a ridge, went down a little valley, and I heard afterwards that they ascended the next slope, which was not more than 1500 yards away from where I stood with a native servant. Yet even this lynx-eyed native could not see them going up this slope. They had vanished from us.

Perhaps it may interest some of your readers that zebras are still fairly plentiful on the rugged hills west of Cradock. A troop of forty-one individuals was seen, on the very ground over which we hunted, a short time before we arrived. Our party saw eleven in two days, but I believe three were seen on two if not on three different occasions. This would reduce their number to eight, if not to five. They are protected by Government, and also by the farmers themselves, but I am afraid that in spite of that their days are numbered. They are said to be very destructive to wire fences, and as the inclosing of farms with wire fences is steadily on the increase in this colony, many a farmer will have, though perhaps reluctantly and in defiance of the law, to take up his gun and clear them off his property. There will then probably be an outcry by people who know the difficulties of South African farming only from books written by travellers who hurry through South Africa in a first-class railway carriage; but those who really know South Africa well will say it is a great, great pity, but it cannot be helped, unless Government provides speedily an abode for these and other animals threatened with extinction. The first step in the right direction would perhaps be the establishment of a Government Zoological Garden, but I hope others who are more competent than I am will stir the people of Cape Colony up before it is too late, so that something more than mere game-laws may be done to preserve them.

S. SCHÖNLAND.

Albany Museum, Grahamstown.

The Protective Device of an Annelid.

IN September last I forwarded to NATURE the description of an effectual protective device adopted by a small tubicolous Annelid which had been sent to me from Jersey; the device consisting in the coiling-up of the end of the tube. I have recently been able to submit specimens to Prof. W. C. McIntosh, of St. Andrews, who has kindly identified the builder as *Sabella saxicava*, a form which he tells me is common in the Channel Islands, and occurs also on our southern coast. So far as I can learn, this peculiar and interesting habit of an Annelid had not previously been observed.

ARNOLD T. WATSON.

Sheffield, May 1892.

The General Circulation of the Atmosphere.

IN that excellent lecture by Dr. Pernter, delivered before the Scientific Club at Vienna, published by you in NATURE (vol. xlv. p. 593), the theory of the trade winds being occasioned by the rising of the rarefied air at the equator causing an upward current, while cold air from north and south flows in to supply its place, coupled with the earth's rotation to the east, is attributed to Dr. Dove. "Dove was the first person . . ." But that theory will be found distinctly enunciated by Sir John Herschel in his "Treatise on Astronomy" (1833), where he attributes it to Captain Basil Hall, "where this is distinctly, and, as far as I am aware, for the first time reasoned out." Herschel was not aware that it had been distinctly reasoned out by George Hadley, F.R.S., in the thirty-ninth volume of the Philosophical Transactions, a century before Basil Hall.

J. CARRICK MOORE.

THE SURFACE-FILM OF WATER, AND ITS RELATION TO THE LIFE OF PLANTS AND ANIMALS.[1]

IT is necessary to the exposition of my subject that I should begin by reminding you of some well-known properties of the surface of water. These are familiar to every student of physics, and are set forth in many elementary books. They are well explained and illustrated, for instance, in Prof. Boys's deservedly popular book on "Soap-bubbles." But there may be some persons here who have not quite recently given their thoughts to this subject, and it will only cost us a few minutes to repeat a few simple experiments, which will establish some fundamental facts relating to the surface-film of water.

The following experiments were then shown:—

(1) Mensbrugghe's float. Proves that the surface-film of water offers resistance to the passage of a solid body from beneath.

(2) Aluminium wire made to float on water. Proves that the surface-film of water offers resistance to the passage of a solid body from above. The resistance is proportional to the length of the line of contact of the solid with the water.

(3) Copper gauze made to float on water. Here, a number of intersecting wires are employed instead of a single wire, and the consequent increase in the length of the line of contact greatly increases the weight which can be supported.

(4) Frame with vertical threads, carrying a light plate of brass. The threads hang vertically at first, but when the whole is dipped into soapy water, the adhering film exerts a pull upon the sides of the frame, draws the threads into regular curves, and raises the brass plate. When the film is broken, the threads resume their previous vertical position, and the plate falls.

(5) Aluminium wire supported by vertical copper wires. Each end of the aluminium wire forms a loop, which fits loosely to one of the copper wires. When the apparatus is dipped into soapy water, the contraction of the film draws the aluminium wire upwards. After pulling it down with a thread, the wire can be again drawn up. This is another illustration of the tendency of the film to contract. We use soapy water, because the film lasts for a considerable time, but the surface-film of pure water, though less viscous than that of soapy water, is even more contractile. We have already seen that the surface-film clings with considerable tenacity to any solid body introduced into it, and that its hold increases with the length of the line of contact. It is for this reason that fine meshes offer so great a resistance to the passage of the surface-film. Air can pass through the meshes with perfect ease; water also, if not at the surface, can pass through readily enough, but the surface-film in contact with air will only pass through with

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[1] Lecture given at the Royal Institution, March 4, 1892, by L. C. Miall, Professor of Biology at the Yorkshire College, Leeds. Some passages were omitted in delivery, for want of time.

difficulty, and if there is water behind it, the water may thus be restrained from passing through the meshes.

(6) Muslin bag hung in front of the lantern. Water poured into the bag (a large spoonful) does not flow out; but when the muslin beneath the water is rubbed with a rod, it becomes wetted, the surface-film passes to the outside of the bag, and the water trickles through.

There are many plants which take advantage of this property of the surface-film of water, viz. that it will not penetrate small spaces, in order to keep themselves dry. You must have observed how the hairy grasses repel water. The surface-film is unable to pass into the fine space between the hairs, and accordingly the water above the surface-film is kept from contact with the leaf. This simple artifice is often employed by plants which float at the surface of water. Here it is important that they should keep dry, not only for the purpose of respiration, but for another reason too. They commonly have great power of righting themselves when accidentally submerged, and this self-righting property depends upon the fact that the under surface of each leaf is always wet, while the upper surface is incapable of being wetted.

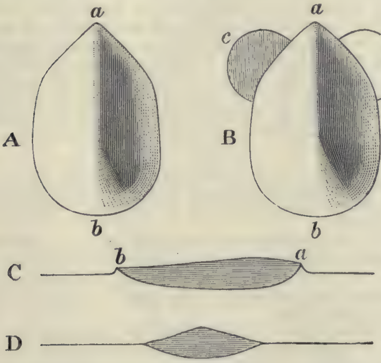

Fig. 1.—Duckweed (*Lemna minor*), magnified. A, single frond; *a*, scar of attachment to parent. A ridge extends from *a* to *b* across the upper surface of the frond, gently subsiding towards *b*. B, frond, budding-out two new fronds. C, longitudinal section from *a* to *b* (A), showing ascending capillary curves at *a* and *b*. D, transverse section, at right angles to the last. The margins of the frond in this plane are level with the surface of the water. N.B. The form of the fronds is somewhat variable. Minor inequalities occur along the margin, but the principal ascending curves, which are also centres of attraction, are at *a*, *b*, and *c*.

The microscopic hairs which thickly cover the upper surface are sufficient to exclude the water. A leaf of Pistia is now submerged, and shown as an opaque object in the lantern. You see by the gleaming of its surface that it is overspread by a continuous flat bubble of air, which looks like quicksilver beneath the water. I will next invert a leaf of Pistia by means of a rotating lever. It is now brought up beneath the surface of the water in an inverted position, and you see that, notwithstanding its buoyancy, it is unable to free itself and rise to the surface, because of the air-bubble, which adheres both to the leaf and to the disk at the end of the lever, and ties both together. Complete separation of the leaf from the disk would involve the division of the air-bubble into two smaller bubbles, one adhering to the leaf and the other to the disk. In this operation the surface-film would necessarily be extended directly in opposition to its natural tendency to contract. Several other water-plants exhibit the same properties as Pistia. I will mention two of the water-ferns—Salvinia and Azolla. Salvinia is found floating on still water in the warmer parts of Europe, as well as in other quarters of the globe. The leaves are attached on opposite sides of a horizontal stem. Long hairy roots (or what look like roots, and really answer the same purpose) hang down into the water. Salvinia has in a remarkable degree the power of rising when submerged, of always rising with its leaves up and its roots down, and of rising with the upper surface of its leaves perfectly dry. It is obvious that these qualities are most useful to a plant which may be pressed under water or drenched with rain. Its nutrition, like that of all green plants, depends largely upon substances extracted from the air; and to be overspread with water, which disappeared only by a slow process of evaporation, would be disadvantageous, especially if the water were not absolutely clean. Every leaf of Salvinia is, to begin with, excavated by a double layer of air-spaces, which lodge so much air as to give it great buoyancy. On the upper surface are placed at regular distances a number of prominences, each surmounted by a group of about four stiff, spreading hairs, which keep the water from reaching the surface of the leaf. When forcibly depressed, the Salvinia takes down with it a layer of air, which forms a flat bubble over the leaf, and of course gives great power of self-righting, for the specific gravity of the upper

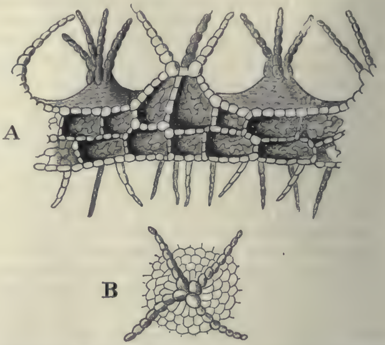

Fig. 2.—*Salvinia natans.* A, combined surface-view and section of floating leaf, modified from a figure in Sachs's "Botany," showing the air-cavities, the submerged hairs of the lower surface, and the groups of stiff hairs on the upper surface. These latter inclose spaces into which water cannot enter, even when the leaf is completely submerged. B, one group of hairs from the upper surface, seen from above.

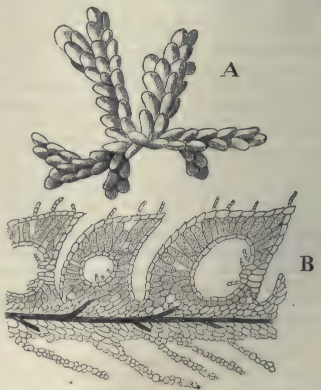

Fig. 3.—*Azolla caroliniana.* A, stem with leaves, magnified; B, longitudinal section through part of ditto, highly magnified. The air-cavities of the leaves are shown, the narrow spaces between the leaves, into which water cannot enter, the fine hairs of the upper surface, the submerged leaf-lobes, and the vascular bundles.

side is greatly reduced, while the lower side is weighted, as before, by the long, water-logged roots. Once restored to the surface, the bubble bursts, and the little drops into which it is instantly resolved roll off like drops of quicksilver. Azolla, which is found in most hot countries, and is often grown in hothouses, behaves in a very similar way. Here the leaves are far smaller, and crowded together upon a branching stem of minute size. There are a few hairs upon the upper surface, and between the leaves are narrow clefts, connected with globular cavities, which occupy the centre of every leaf. These cavities, which are often closed, and never possess more than an outlet of extreme minuteness, are always filled with air; so are the clefts between the leaves. No water can lodge on the upper surface, apparently because the surface-film is stretched from the raised edge of one leaf to that of the next; and thus buoyancy, self-righting, and repulsion of water are efficiently secured.

Many plants which ordinarily float on the surface of the water (Salvinia, Azolla, Duckweed, *Potamogeton natans*, &c.) sink on the approach of winter. At this time it is very curious to see how completely they lose both their buoyancy and their power of repelling water. I do not know how this change is brought about, but the result is one of obvious advantage. The leaves, or in some cases the entire plants, sink to the bottom, and hibernate there, out of the reach of frost. Many perish; some are broken up by decay into isolated buds. When spring returns, the few survivors float up, and soon cover the surface with leaves. It would be interesting to know something of the mechanism by which these seasonal changes are effected.

One of the commonest objects in Nature, which is apt to escape our notice on account of its minute size, for it is less than one-quarter of an inch in length, is the egg-raft of the gnat. This was beautifully described 150 years ago by Réaumur. The eggs of the gnat are cigar-shaped, and 250 or 300 of them are glued together, so as to make a little concave float, shaped like a shallow boat. The upper end of each egg is pointed; the lower end is provided with a lid, through which the larva will ultimately issue into the water. The gnat in all stages, even while still in the egg, requires an ample supply of air. It is therefore necessary that the egg-raft should float at the surface; it is also necessary that it should always float in the same position, so as to facilitate the escape of the larva. This is effectually secured by a provision of almost amusing simplicity. Let us first notice how efficient it is. If we take two or three of these tiny egg rafts, and place them in a jug of water, we may pour the water into a basin again and again; every time the egg-rafts float instantly to the surface; and the moment they come to the top, they are seen to be as dry as at first. The fact is that the surface-film cannot penetrate the fine spaces between the pointed ends of the eggs. The cavity of the egg-raft is thus overspread by an air-bubble, which breaks the instant it comes to the top. The larva of the gnat, when it escapes from the egg, floats at the surface, and it is enabled to do so in consequence of the properties of the surface-film. When the larva changes to a pupa it becomes buoyant, and floats at the surface, except when alarmed. To enable it to free itself without unnecessary effort from the surface of the water, the respiratory tubes of the pupa are furnished with a valvular apparatus, which can cut the connection with the air in a moment, and restore it at pleasure, when the pupa again floats to the surface.[1]

Another Dipterous insect, whose larva inhabits rapid streams, makes an ingenious use of the properties of the surface-film. This is the larva of Simulium, of which I have given some account in the lecture just quoted. At the time of the delivery of that lecture, I was wholly unable to explain how one difficulty in the life of the insect is surmounted. The larva clings to the water-weeds found in brisk and lively streams. The pupal stage is passed in the same situation. But a time comes when the fly has to emerge. Now the fly is a delicate and minute insect, with gauzy wings. How does it escape from the rushing water into the air above, where the remainder of its life has to be passed? This was a question upon which I had spent much thought, but in vain. It appeared to me for many months completely insoluble. However, I was informed last year by Baron Osten Sacken of a paper written by Verdat, seventy years ago, in which the emergence of the fly of Simulium is described. Guided by Verdat's description, I had little difficulty in seeing for myself how the difficulty is actually overcome. During the latter part of the pupal stage, the pupa-case becomes inflated with air, which is extracted from the water, and passed through the spiracles of the fly into the space immediately within the pupal skin. The pupal skin thus becomes distended with air, and assumes a more rounded shape in consequence. At length it splits along the back, in the way usual among insects, and there emerges a small bubble of air, which rises quickly to the surface of the water and there bursts. When the bubble bursts, out comes the fly. It spreads its hairy legs, and runs upon the surface of the water to find some solid support up which it can climb. As soon as its wings are dry, it flies to the trees or bushes overhanging the stream.

A very interesting inhabitant of the waters, which makes use of the properties of the surface-film to construct for itself a home beneath the surface, is the water-spider (*Argyroneta aquatica*). This interesting little animal has been described by many naturalists, some of whom, judging from their accounts, had no personal acquaintance with its habits. But among the number is the eminent naturalist Félix Plateau, son of the physicist to whom we are so much indebted for our knowledge of the phenomena of surface-tension. I need hardly say that in his account of the water spider, Prof. Plateau gives a full and adequate account of the scientific principles concerned in the formation of its crystalline home.[1] Plateau remarks that the water-spider, like most other spiders, is an air-breathing animal. It dives below the surface, and spends nearly its whole life submerged. In order to do this without interruption to its breathing, the spider carries down a bubble of air, which overspreads the whole abdomen as well as the under side of the thorax. These parts of the body are covered with branched hairs, so fine and close that the surface-film of water cannot pass between them. The spider swims on its back, and the air lodges in the neighbourhood of the respiratory openings, which are placed on that surface which floats uppermost. When the spider comes to the top, as it does from time to time to renew its supply of air, it pushes the abdomen out of the water, and we can then see that this part of the body is completely dry. When it sinks, the water closes in again at a little distance from the body, and the bubble forms once more.

It would be inconvenient to the water-spider to be obliged to come frequently to the surface for the purpose of breathing. A predatory animal on the watch for its victims must lie in ambush close to the spot where they are expected to appear, and the water-spider accordingly requires a lurking-place filled with air, beneath the surface of the water. It has its own way of supplying this want. Relying on the fact, already illustrated by our muslin bag, that the surface-film of water will not readily pass through small openings, the spider proceeds as follows. It begins by drawing together some water-weeds with a few threads, in such a way that they meet at one or more points. It then fetches from the surface a fresh supply of air, and squeezes part of it out by pressing together the bases of its last pair of legs. The bubble rises, but is detained by some of the threads previously spun across its path. Then the spider returns to the surface to fetch another bubble, and repeats the operation as often as is necessary. Now and then she secures the growing bubble by additional threads, and before long has a bubble nearly as big as a walnut, inclosed within an invisible silken net, which imprisons the air as effectually as a dome of glass would do. The spider takes care to conceal her home from observation, and before long the minute Algæ, growing all the more vigorously because of the air brought to them, effectually conceal the habitation. The mouth of the dome, which is of course beneath, is narrowed to a small circle, and Plateau has observed a cylindrical horizontal tube, seven to eight millimetres in diameter, by which the spider is enabled to enter or leave her home without being observed. The air within is renewed as required, by the visits of the spider to the surface.

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[1] The larva and pupa of the gnat are more fully described in my British Association lecture on "Some Difficulties in the Life of Aquatic Insects," reported in NATURE, vol. xliv. p. 457.

[1] "Observations sur l'Argyronète aquatique," *Bull. Acad. Roy. de Belgique*, 2me. sér., tom. xxiii., 1867.

Besides this home, which is the ordinary lurking-place of the spider, another is required at the time when the young are hatched. The new-born spiders are devoid of the velvety covering of hairs, and would drown in a moment if placed in a nursery with a watery floor. The female spider therefore makes a special nest for this particular occasion, which floats on the surface of the water, rising well above it. It is bell-shaped and strongly constructed. The upper part is partitioned off, and contains the eggs. Beneath the floor of the nursery the mother takes her station, and watches over the safety of her brood, defending them against the predatory insects which abound in fresh waters. It is interesting to see how the faculty of spinning silk, used by the house-spider for her snares, and at other times for the fluffy cocoon in which the eggs are enveloped, furnishes to the water-spider the materials of her architecture. It is not less interesting to observe the economy of material which results from the use of the tenacious and contractile surface-film, in place of a solid wall.

We will next consider another property of the surface-film, which is turned to account in the daily life of the very commonest of our floating plants, I mean the duckweed, which overspreads every pond and ditch. A number of the green floating leaves of duckweed are now placed in a shallow dish in the field of the lantern, and I will ask you to observe how they are grouped. They have spontaneously arranged themselves in a very irregular fashion, forming strings and chains which spread hither and thither over the surface of the water. This is not the way in which most floating bodies behave. Let us remove the duckweed, and replace it by another dish of water in which I will put a number of small disks of cork.[1] You will see that the bits of cork are attracted one to another and crowd together in one place. Let us inquire why the floating bits of cork are thus attracted towards one another. If any solid capable of being wetted by water is partly immersed in water, the liquid rises round it in an ascending capillary curve. If the solid is not wetted by water, the curve will turn downwards. We may get ascending or descending capillary curves in other ways. If, for instance, I were to lay a sheet of paper upon water, and turn its edges up at certain places, we should get marked ascending curves at these points. The raising of some parts of the surface causes other parts to sink, and may bring about descending curves, or make previously formed descending curves more marked. We shall find it helpful in our experiments to notice one very simple plan of producing a descending capillary curve round the edge of a vessel. If we take a glass of water, and fill it until the water is level with the brim, we naturally speak of the glass as *full*; but if we are careful to avoid rude shaking, we may still add a considerable quantity of water without spilling any. The glass will then become what we may call *over-full*, and its surface will be bounded by a descending capillary curve. Now, it is of immediate importance to us to observe that *like* capillary curves, whether ascending or descending, attract one another, and that *unlike* curves repel one another. The theoretical explanation of this point is not difficult, but it must not detain us here. To place the fact itself beyond dispute, we will try a little experiment. A circular dish of water is now placed in the field of the lantern, and we will introduce into it a small disk of wood. Both the disk and the side of the vessel are wetted by water, and an ascending capillary curve rises round each. The result is that the two bodies attract one another. Every time the disk is moved away it is powerfully drawn towards the side of the vessel. With a little syringe we will add water to the dish in sufficient quantity to raise the level above the edge of the vessel. You will observe that the wooden disk is now repelled by the edge of the vessel, and floats free in the centre. By sucking up a little water, it becomes attracted once more, and so we may go on, causing it to be attracted or repelled, according as we add or subtract a small quantity of water. But what has all this to do with the duckweed? In order to explain the behaviour of duckweed, I must ask you to examine a careful representation of its form. This common plant has not, to my knowledge, been faithfully represented in any botanical book. You will see that the leaf is of an irregular oval shape, broader at one end than at the other, and that the narrow end is pointed. A raised ridge extends along the length of the leaf, from the point to the middle of the opposite or rounded border. Duckweed almost invariably propagates itself by budding. New leaves are pushed out symmetrically on each side of the point. They grow bigger and bigger, and gradually free themselves. The point upon each leaf marks the place where it was last attached to the parent leaf. Sometimes the budding is so rapid, that, before a fresh pair of leaves have become free, they have already budded out a second pair, which we may call the granddaughters of the parent leaf. The pointed end of the leaf, and also the opposite end of the ridge, are raised above the general level, and very marked capillary curves ascend from the general water-level to these points. The free edge of every bud is also raised above the general water-level, and a capillary curve ascends to meet it. Hence, when a number of leaves of duckweed are floating freely on water, they are powerfully attracted one to another at certain points, while at intervening points they are relatively inert. If you take a floating leaf of duckweed, and bring near it a clean needle or a pencil-point, or any similar object, provided that it is not greasy, you will see that the leaf is at once attracted towards the point, but it always turns itself so as to bring one of its ascending curves round to the needle or pencil. We all see in the lantern how readily a leaf of duckweed is made to rotate rapidly by causing a needle-point to revolve round it, without ever touching it. Let us now try to imitate the behaviour of the leaves by some rude models. I have here some elliptical paper floats, cut out with a pair of scissors, and having each of the pointed ends a little turned up. We place these one by one on the surface of the water, and you see in the lantern how they are attracted to one another, point to point, and how they form long chains, which have a tendency to break up into stars. It is the existence of such points of attraction on the margin of the leaves which causes the duckweed to form chains and strings, so long as there is any unoccupied surface in the pond. A moment's consideration shows how profitable this tendency is to the plant. Were the duckweed to crowd together like the floating bits of cork, the pressure towards the centre of any considerable mass of plants would be so great that the new leaves budded out would find no room in which to expand; but, by virtue of one very simple provision, viz. the existence of inequalities of level along the edges of the leaves, clear spaces and lanes are left between the floating leaves, so long as any unoccupied space remains.

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[1] In order to avoid the inconvenience caused by the attraction of the sides of the vessel, the dish should be over-full of water.

Long exposure to the air, especially in still weather, affects the life of duckweed in a material way. Dust and decaying organic substances give rise to a pellicle, which is most mischievous to floating plants; and I think I could show, if time allowed, how much the habits of duckweed have been altered thereby. But, apart from visible impurities, mere exposure to air gives, as Lord Rayleigh has taught us, a considerable degree of superficial viscosity to water. Hence, the leaves of duckweed, when the surface is contaminated, will tend to lie in whatever positions they may be thrown by accidental causes, such as wind, and the attractions due to capillarity will be more or less impeded. But the effect of the superficial viscosity will in time be overcome by the attractive forces, so that it probably does not in the long run greatly affect the distribution of the leaves over the surface of water.

Many other floating plants, but not all, behave more or less like duckweed, and for the same reason. As yet I know of none which space themselves quite so effectually, and the extreme abundance of the common duckweed, as well as its world-wide distribution, may be partly due to the completeness of its adaptation to capillary forces. Some dead objects may accidentally take a shape which causes them to spread out over water, but I have met with none which have particularly struck me. Floating natural objects, such as sticks or seeds, behave, in many cases at least, very differently, and become densely massed. My attention was first called to this subject by seeing how different was the grouping of duckweed from that of some seeds of *Potamogeton natans*, which were floating in the same pond.

The capillary forces which spread the leaves of duckweed or Azolla upon the surface of water are indirectly concerned in the transport of these and like plants to fresh sites. If we put a stick into water overspread with duckweed, we cannot fail to notice how the leaves cling to the stick. They cling in a particular way, which enables them to bear transport more safely. The wetted surface, for obvious physical reasons, is attracted to the wetted stick; and the water-repellent surface, which is that which best resists drying, is outwards. The tenacity with which duckweed clings to the legs of water-birds, and the position which it almost inevitably takes under such circumstances, may have a good deal to do with the safe transport of the plant to distant pools. It is not, I think, too much to say that the prosperity of duckweed depends very largely upon the capillary forces which come into play at the surface of water.

We have now exhausted our time, though I have been obliged to leave unnoticed many special adaptations of living things to the peculiar conditions which obtain on the surface of water. Had time allowed, I should have been glad to say something about the aquatic animals which creep on the surface-film as on a ceiling, and about the insects which run and even leap upon the surface-film without wetting their minute and hairy bodies.[1] All small animals and plants which float on water necessarily come into contact with the surface-film, and have to deal with the difficulties which result from it. We have seen that they generally manage in the long run to convert these natural difficulties into positive advantages.

I have to thank my colleague, Dr. Stroud, for his frequent explanations of the physical principles upon which these adaptations depend, and also for much practical and valuable help in the preparation of suitable experiments.

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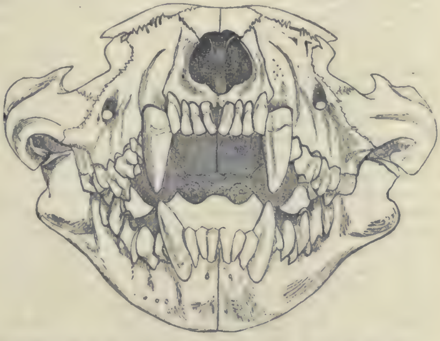
[1] See NATURE, vol. xliv. p. 457.

THE DISCOVERY OF AUSTRALIAN-LIKE MAMMALS IN SOUTH AMERICA.

THE year 1891 proved a notable one in regard to marsupials. The existing mole-like marsupial (*Notoryctes*) from the deserts of Central Australia having been made known to us, news came of the discovery in the Tertiaries of Patagonia of remains of carnivorous marsupials closely allied to the existing pouched wolf, or Thylacine, of Tasmania. This discovery was immediately recognized as one likely to considerably modify some of our views regarding the distribution of mammals. A preliminary account of these new marsupials was given by Dr. Florentino Ameghino in a paper written for the new serial, *Revist. Argent. Hist. Nat.* This description seems to leave no doubt as to the correctness of the diagnosis of the fossil remains.

Before going further, it may be well to remind our readers that, with the single exception of the opossums (*Didelphyidæ*) of America, all marsupials are now exclusively Australasian. The carnivorous types, such as the Thylacine (*Thylacinus*) and the Tasmanian Devil (*Sarcophilus*), are distinguished from all living mammals in that their upper cutting-teeth (incisors) are either four or five in number on either side, while in the lower jaw there are invariably three. This relation is shown in the figure of the skull of the Tasmanian Devil—a near ally of the Thylacine—where, between the large tusks of the upper jaw, we see the four pairs of incisors opposed to only three pairs in the lower jaw. In ordinary mammals, on the other hand, the number of pairs of incisors in each jaw does not exceed three, the number of those in the two jaws being usually equal. A further peculiarity of marsupials is that the cheek or grinding teeth comprise four true molars and not more than three premolars; whereas in ordinary mammals the typical number is three molars and four premolars, there being no known instance of the presence of four true molars except in some individuals of the fox-like *Otocyon*. Another peculiarity of most marsupials is the distinct inflection of the lower posterior extremity, or "angle," of the lower jaw, while very frequently the bony palate of the skull has unossified spaces.



Front view of the skull of the Tasmanian Devil. (After Flower.)

The new forms described by Dr. Ameghino were obtained from the lower part of that great series of freshwater formations with which so large an area of South America is covered. It has been inferred that the Patagonian deposits in question are as old as the Lower Eocene of Europe; but, although they are undoubtedly of considerable age, this inference can scarcely be regarded as an established fact, since the occurrence of mammals allied to those of the European Lower Eocene is quite capable of explanation by their survival to a later period in South America.

One of the new Patagonian forms, to which Dr. Ameghino applies the name *Prothylacinus*, is stated to be an animal of the general conformation of the Thylacine, having apparently the same number of teeth, although the upper incisors are unknown. The main distinction of the fossil genus is, indeed, said to consist merely in the circumstance that the lower premolars are more widely separated from one another; the molars of the two forms being described as absolutely identical in character. The fossil likewise exhibits the marsupial inflection of the angle of the lower jaw. The absence of the upper incisors in the specimens of *Prothylacinus* is fortunately compensated in another genus described under the uncouth name of *Protoproviverra*. Here we find that the number of teeth is exactly the same as in the Thylacine, there being four upper and three lower incisors, a canine, three premolars, and four molars on each side of the skull. This dentition agrees numerically with that of the Tasmanian Devil; with the exception that there is an additional premolar in each jaw. These fossils also exhibit the inflection of the angle of the mandible, and the presence of unossified vacuities in the palate, which we have seen to be marsupial features.

As might have been expected to be the case, Dr. Ameghino also states that there appears to be a complete passage from these marsupial forms to others belonging to that group of primitive carnivores known as Creodonts, of which the European Upper Eocene *Hyænodon* and *Pterodon* are well-known examples. Now, if we are to trust these descriptions (and there appears every reason why we should), we must admit that *Prothylacinus* and *Protoproviverra* are veritable marsupials of an Australian type. Then comes the question, How are we to explain the occurrence of such closely allied forms in areas so remote from one another as Patagonia and Australia?

It had long ago been urged that the occurrence of carnivorous marsupials in South America and Australia and nowhere else (at the present time) indicated a former connection between those two areas. To this, however, Mr. Wallace ("Distribution of Animals," vol. i. p. 399) objected that the American opossums (*Didelphyidæ*) were not an Australian type, and that they occurred in the Tertiaries of Europe; and hence he argued that both the American and Australian marsupials probably took their origin from the presumed marsupials of the European Jurassic rocks. This explanation, on Mr. Wallace's own showing, will not, however, hold good for the close resemblance stated to exist between the American *Prothylacinus* and the Tasmanian Thylacine, since it is quite impossible to believe that two such similar forms could have maintained their likeness in such remote regions after having diverged from a common European ancestor as far back as the Jurassic period.

It has, however, been long known that there are certain very remarkable relationships between the fauna and flora of all the great southern continents. For instance, among mammals, the rodent family *Octodontidæ* is peculiar to South (including Central) America and Ethiopian Africa. Then, again, among fishes, the family of the *Chromidæ* is confined to the rivers of South America and Africa, with one outlying genus in India; while the true mud-fishes (*Lepidosiren* and *Protopterus*) are solely South American and Ethiopian, the third representative of the same family being the Baramunda (*Neoceratodus*) of Queensland. Again, the connection between the flora of Africa and that of Western Australia is so intimate as to have induced Mr. Wallace (*op. cit.*, p. 287) to express his belief that there must have been some kind of land connection, although not necessarily a continuous one, between these two widely distant areas. The connection between the fauna of India and that of Ethiopian Africa is now too well known to stand in need of comment. The matter does not, however, end here; for if we go back to the Mesozoic epoch there are equally striking evidences of the connection between the faunas and floras of the southern continents. For instance, the extinct saurian genus *Mesosternum*, which appears to have been allied to the Plesiosaurs of the Lias, is known from early Secondary strata in Brazil and South Africa, and nowhere else. Then, again, the remarkable Anomodont reptiles (*Dicynodon*, &c.) of South Africa are closely connected with those of India; while the respective alliances between the Labyrinthodont amphibians and the Mesozoic floras of South Africa, India, and Australia are too well known to need more than mention.

It appears, then, that, altogether apart from the new discovery, the common factors connecting the faunas and floras of the four great southern prolongations of the continental land of the globe undoubtedly point, not only to a more or less intimate connection between these several areas, but also to their more or less partial isolation from the more northern lands.

Reverting to the new discovery, it may be observed that our comparatively intimate acquaintance with the Tertiary faunas of Europe and North America renders it in the highest degree improbable that marsupials of an Australian type lived during that time in either of those areas. It is, however, quite possible that they may turn up at any time in Tertiary formations in Africa, while there is nothing to show that they may not also have existed in peninsular India. Indeed, if we put aside as improbable any connection by way of the Pacific between South America and Australia, it seems impossible to give any explanation of the occurrence of allied marsupials in Patagonia and Australia without the assumption that their ancestors existed in some part of the great area lying between eastern South America and Western Australia.

R. Lydekker.

PHOTOGRAPHY IN COLOURS.

The *Comptes rendus* for February 2, 1891, contained a brief note on colour photography, describing the method employed by M. G. Lippmann, who had been able to produce photographically the image of the spectrum with all its colours. A summary of this note was given in Nature at the time (see vol. xlviii., p. 360).

M. G. Lippmann, who has been continuing his researches, has communicated further results, which appear in the *Comptes rendus* for April 25 (No. 17, vol. cxiv.). These results show that we are not far off the solution of a question which has been the aim of all the latest photographic researches. The following is a translation of the note in question:—

In the first communication which I had the honour to make to the Academy on this subject, I stated that the sensitive films that I then employed failed in sensitiveness and isochromatism, and that these defects were the chief obstacle to the general application of the method that I had suggested. Since then I have succeeded in improving the sensitive film, and, although much still remains to be done, the new results are sufficiently encouraging to permit me to place them before the Academy.

On the albumen-bromide of silver films rendered orthochromatic by azalin and cyanin, I have obtained very brilliant photographs of spectra. All the colours appear at once, even the red, without the interposition of coloured screens, and after an exposure varying from five to thirty seconds.

On two of these *clichés* it has been remarked that the colours seen by transmission are very plainly complementary to those that are seen by reflection.

The theory shows that the complex colours that adorn natural objects ought to be photographed just the same as the simple colours of a spectrum. There was no necessity to verify the fact experimentally. The four *clichés* that I have the honour of submitting to the Academy represent faithfully some objects sufficiently diverse, a stained glass window of four colours, red, green, blue, yellow; a group of draperies; a plate of oranges, surmounted by a red poppy; a many-coloured parrot. These showed that the shape is represented simultaneously with the colours.

The draperies and the bird required from five to ten minutes' exposure to the electric light or the sun. The other objects were obtained after many hours of exposure to a diffuse light. The green of the foliage, the grey of the stone of a building, are perfectly produced on another *cliché*; the blue of the sky, on the contrary, was represented as indigo. It remains, then, to perfect the orthochromatism of the plate, and to increase considerably its sensibility.

NOTES.

THE Royal Society's *soirée* is being held as we go to press. We hope to give next week some account of the principal objects exhibited.

THE Bureau des Longitudes is sending an expedition to Senegambia to observe the total solar eclipse of April 1893.

THE first session of the Institution of Mining and Metallurgy is to be held in the theatre of the Geological Museum, Jermyn Street, on Wednesday, May 18, when the President, Mr. George Seymour, will deliver the inaugural address. There will be an inaugural supper at the Criterion.

AT the Royal Academy dinner Sir John Lubbock responded for science. He said that no class derived more benefit and enjoyment from works of art than men of science. Sir John referred also to the growing importance of art in relation to the material prosperity of the country. Our merchants and manufacturers, he said, could no longer rely entirely on excellence of material and solidity of workmanship, but had to look to artistic charm and beauty of design.

AT the annual meeting of the Royal Institution on May 2, the following gentlemen were elected officers for the ensuing year: the Duke of Northumberland, President; Sir James Crichton-Browne, Treasurer; Sir Frederick Bramwell, Secretary.

IT is reported from Melbourne that Sir Thomas Elder has decided not to send out another exploring expedition into Central Australia at present. He attributes the failure of his recent expedition, under Mr. Lindsay, to the severity of the season, the drought having been unusually trying.

ON May 7 the members of the Geologists' Association will make an excursion to Walthamstow, Mr. J. Walter Gregory acting as director. The object of the excursionists will be to examine sections on the Tottenham and Forest Gate Railway. The best section is about half a mile from St. James's Street, and shows the lower terraces of the Lea Valley gravels resting on a very eroded surface of London Clay. Masses of the London Clay stand up, which were probably once islets. The alterations in the position of the bed of the Lea are well shown by this cutting.

ON Tuesday next (May 10) Mr. Frederick E. Ives will begin a course of two lectures at the Royal Institution on photography in the colours of nature.

AT the meeting of the Franklin Institute, Philadelphia, on March 16, Mr. John Carbutt made some remarks on the results achieved by Mr. Frederick E. Ives in the field of colour photography, which, in his judgment, so far as practical results were concerned, were far in advance of anything that had as yet been accomplished elsewhere. Mr. Carbutt urged that it was eminently fitting for the Institute to recognize the value of the work of one of its own members, and moved that the subject of Mr. Ives's investigations and results in the field of colour photography should be referred to the committee on science and the arts for investigation and appropriate recognition. The motion was carried.

SIR JAMES CRICHTON-BROWNE delivered the annual oration at the 118th anniversary meeting of the Medical Society of London, held on Monday evening. He chose as his subject "Sex in Education." He showed that the female brain is lighter than that of the male, not only absolutely, but relatively to the respective statures and weights of the two sexes; that the specific gravity of parts of the female brain is less than that of corresponding parts of the male brain; and that the blood supply, which in the male is directed more towards the portions which are concerned in volition, cognition, and the ideo-motor processes, is in the female more directed towards portions which are mainly concerned in the discharge of sensory functions. Sir James urged the necessity of such structural differences being taken into account in the conduct of education; and, while disclaiming any intention of bringing a wholesale indictment against high schools for girls, he nevertheless held that some of their methods were capable of leading to great evils, especially when not controlled by a judicious and sympathetic mistress. He pointed out the difficulty of obtaining trustworthy information as to either the methods of many schools or their effects, more especially as the pupils themselves were often hostile to the inquiry; but he referred to one school at which he had been permitted to ascertain the facts, and in which he found that, out of 187 girls belonging to the upper and middle classes, well-fed and clad and cared for, and ranging from ten to seventeen years of age, as many as 137 complained of headaches, which in 65 instances occurred occasionally, in 48 frequently, and in 24 habitually. He cited the authority of Sir Richard Owen for the position that children have no business with headaches, and that something must be wrong in the school in which they frequently suffer from them. An account was given of the *modus operandi* of excessive brain work as a factor in the production of ill-health, and statistics were quoted to show the special liability of the female organism to disease at the period of life which the educator has seized on for his own. He attached great importance to loss of appetite, especially morning appetite, as a result of overstrain, and as one which was calculated to be itself the fruitful parent of other evils; and he strongly condemned the recent decision of the University of St. Andrews to open its classes in arts, science, and theology to women as well as to men, thus, as he declared, taking not a retrograde step, but a downhill step towards confusion and disaster. "What was decided amongst the prehistoric protozoa cannot be annulled by Act of Parliament; and the essential difference between male and female cannot be obliterated at a sweep of the pen by any Senatus Academicus."

THE weather during the past week has been unsettled generally, and showers of cold rain, hail, or sleet have occurred in many districts. The day temperatures have been low, with sharp frosts at night; on April 29 the thermometer on the grass fell as low as 20° in London, and heavy snow fell at Wick. From official reports for the week ended April 30 the temperature was several degrees below the mean for the week in all districts, although the bright sunshine had exceeded the normal amount. Gales were experienced on our exposed north and west coasts, but for the most part the wind has been light. Bright aurora has again been seen at several places. On May 1 the thermometer rose to 60° or more at several inland stations, but this improvement was not maintained. The winds, which during a few days were northerly and north-westerly, again became easterly over the whole of the British Isles, with unsettled and unseasonable weather.

A SPECIAL meeting of the New England Meteorological Society was held in Boston on April 6, when the recommendation of the Council to transfer the weather service of the Society to the National Weather Bureau at Washington, with the object of forming a New England Weather Service under the direction of that Bureau, was formally ratified. The New England Weather Service will continue to gather and publish observations of temperature and rainfall, and the monthly *Bulletin* will be continued as heretofore. While that part of the Society's work, in which the greater number of persons is involved, is thus transferred to the New England Weather Service, the meetings and investigations of the Society will be continued as during the past eight years. Three meetings will be held annually, and the proceedings will be published in the *American Meteorological Journal*, while the investigations will be published in the Annals of the Harvard College Observatory. In the *Bulletin* for March, it is stated that it is the intention of the Weather Bureau to make a special study of thunderstorms during the coming summer. The observations are to be made in several States, from May to August inclusive.

THE Deutsche Seewarte (Hamburg) has recently issued an atlas of thirty-five charts, with introductory text, showing the physical conditions of the Indian Ocean, on a similar plan to that published for the Atlantic Ocean some years ago. The rich materials at the disposal of the Seewarte have been discussed by Dr. Köppen and others in every form that can be of use both to seamen and physicists. Several charts are devoted to the currents, temperature and specific gravity, winds and monsoons, while the magnetic elements have been specially investigated by Dr. Neumayer.

THE Indian journals received by this week's mails report that Mr. John Eliot, the Meteorological Reporter to the Government of India, has returned to Simla from Chaman and Murree, where he has been establishing new meteorological observatories.

ON Friday last Colonel J. F. Maurice, Professor of Military Art and History to the Staff College, read at the meeting of the Royal United Service Institution a most interesting paper on military geography. This he described as a science dealing with all those conditions of the surface of the world which affected armies, campaigns, and battles. He sought to show how in the case of each of the great European countries strategic methods are affected by geographical conditions.

OPINIONS are being expressed by scientific workers in India in favour of the making of systematic experiments with snake poison. The Committee for the Management of the Calcutta Zoological Gardens are constructing, from private subscriptions a snake-house with the most modern improvements, which will contain specimens of all the principal poisonous snakes in the country. If the necessary funds were available, arrangements could be made to fit up a small laboratory in connection with the snake-house, for the purpose of conducting inquiries of all descriptions bearing upon the pathology of snake-bite and cognate subjects, and in future there would be no difficulty in arranging for the carrying out of any special experiments that might be required. It is understood that Dr. D. D. Cunningham, F.R.S., President of the Committee, would in that case be willing to take an active part in organizing and promoting such inquiries and carrying out such experiments, including the testing of the various alleged remedies for snake-bite which are from time to time brought to notice. A Calcutta paper, quoted by the *Pioneer Mail*, understands that if the Government of India will make a grant of Rs. 5000 towards this object, the Lieutenant-Governor will endeavour to meet the balance from Provincial funds.

THE well-known mycologist, Dr. Stephan Schulzer von Müggenburg, has just died at the age of ninety.

AT the coming "World's Columbian Exposition" at Chicago, it is proposed to have an exhibition of the "worst weeds" from all the States and Territories of the Union.

UNDER the editorship of Mr. E. M. Holmes a Catalogue has just been issued of the "Hanbury Herbarium" in the Museum of the Pharmaceutical Society. The collection consists of above 600 dried specimens of plants yielding products used in pharmacy, or believed to have medicinal properties, each specimen being labelled with its locality or the source whence it was obtained, and often accompanied by notes or extracts from letters of foreign correspondents. The collection was formed by the late Daniel Hanbury, F.R.S.; and, by the desire of his executors, who presented it to the Pharmaceutical Society, it is preserved in a separate room, known as the "Hanbury Room," on the premises of the Society in Bloomsbury Square.

THE second part of "Botanicon Sinicum," by Dr. Bretschneider, the learned physician to the Russian Legation in Pekin, has just been issued in Shanghai in the Journal of the North China Branch of the Royal Asiatic Society. The work deals with the botany of the Chinese classics, the object being to identify as far as possible the plants mentioned in the writings of Confucius, Mencius, and the other great sages of ancient China. Dr. Bretschneider takes each name in succession, supplies all the information given by native commentators on these ancient writers, and by lexicographers; then he gives all that can be gleaned from Japanese authorities, and follows this by the identifications of European students; concluding with the results of his own study and observation. Those whom Dr. Bretschneider's labours for the past twenty-five years have taught to expect profound learning, research, and thoroughness from him will not be disappointed in this work.

AMONG the contents of the new number of the Journal of the Royal Horticultural Society are the interesting papers read at the Conference on asters and perennial sunflowers, held at Chiswick in October last. The proceedings of the Conference were opened by an address by Mr. J. G. Baker, which is now printed. In this excellent address, in which the general botanical outlines of the subject are sketched out, Mr. Baker mentions that aster as it stands at present contains 200 or 300 species, and is concentrated in the United States. Nearly all our garden Michaelmas daisies belong to the species that grow wild in the Eastern United States. There are forty species of aster in the Rocky Mountains and fifteen in California, most of which are different from the eastern species, and have not been brought into cultivation. The papers published with Mr. Baker's address are on the genus aster, by Prof. G. L. Goodale; the Michaelmas daisy as a garden plant, by the Rev. C. W. Dod; perennial sunflowers, by Mr. D. Dewar; and the culture of sunflowers, by Mr. E. H. Jenkins.

THE "University Extension" movement has spread to the United States. We learn from the *Botanical Gazette* that Prof. J. M. Coulter, President of the University of Missouri, is lecturing to large University Extension classes in Evansville and New Albany, Indiana, and Louisville, Kentucky. Each course includes twelve lectures on the general morphology and physiology of plants.

AUSTRALIANS have had bitter experience of the mischief which rabbits are capable of doing, and now they seem likely to have trouble of a similar kind from the introduction of foxes. An Australian journal, quoted in the May number of the *Zoologist* says that foxes have already spread over a wide area, and are most destructive both to lambs and poultry. They attain greater size and strength in Australia than in England, and the mild climate is highly favourable to the increase of their numbers. "It must be very disheartening," says the writer, "to all who have stock of any kind to lose, to find themselve confronted by some new enemy introduced by thoughtless or selfish persons. If some energetic steps are not soon taken, nothing can prevent the spread of foxes over the whole continent."

MR. D. L. THORPE writes from Carlisle to the *Zoologist* that starlings in that district often reproduce the notes of the oystercatcher and curlew with wonderful accuracy. On April 3 he was surprised to hear the call of the landrail; it appeared to be the familiar "crake-crake" of that bird undoubtedly, but on further investigation he ascertained that a starling was reproducing the call-note of the rail. The bird had remembered his lesson of last summer remarkably well. Mr. Thorpe also mentions that, during severe weather in January last, a friend of his (the Rev. H. A. Macpherson) was astonished one day to hear the call-note of the common sandpiper repeated with such nicety as to completely deceive him, until the starling was detected in the act of rehearsing this summer cry.

A CAPITAL lecture on Egyptian agriculture was delivered by Prof. Robert Wallace at the meeting of the Society of Arts on April 27, and is printed in the current number of the Society's Journal. Referring to the Tewfikieh College of Agriculture, Prof. Wallace says that it was named in honour of the late Khedive (Tewfik Pasha), who took a special interest in its success. It had its origin in a desire which sprang up little more than two years ago in the Egyptian Government to develop the agricultural resources of the country by calling in the aid of science. The result has been a success far beyond the most sanguine anticipations. During the first year of its existence the College contained about 60 students, selected from about 300 applicants, and the numbers of the second, the current year, which began last October, have not fallen off. A number of the sons of large land-owners have taken advantage of the instruction offered, and it is hoped by this means to spread in all directions a knowledge of improved varieties of crop plants, improved rotations, improved implements, and improved methods, not neccessarily altogether new to the country, but deserving of being more widely known.

MR. W. F. LIESCHING, writing in the new number of the Selborne Society's Magazine on ants in Ceylon, says he saw one day a string of ants streaming forth, evidently in search of "pastures new." He flicked away the leader, and waited to see the result. An immediate halt was made by the foremost ants, and a scene of the utmost confusion ensued. The ants from behind kept arriving at the scene of the catastrophe, and there was soon a black crowd of ants huddling and jostling one another. Some detached themselves from the main group and took a turn round, trying to find traces of their leader. At last the tail end of the line arrived, and after brief consultation they all started off again, and a line soon began to unravel itself from the tangled mass moving back to the hole from which the whole company had so lately started on "pleasure bound or labour all intent." While Mr. Liesching was watching the return journey, a leech stung his leg. He took the creature off, and put it down in the line of march. Ants will carry off a worm, why not a leech? It was, however, most amusing to see how carefully all avoided the leech.

HENRY BRUGSCH PASHA read an interesting paper on Lake Mœris at the meeting of the Société de Géographie Khediviale on April 8. He had just returned from a visit to the neighbourhood of the supposed site of the lake, so that the subject was fresh in his mind. The *Times* has given a good abstract of the paper. M. Brugsch said there was abundant monumental evidence that at a very early period of Egyptian history there existed near the plateau of Hawara an immense basin of water, which gave its name to a whole province, the Fayûm, or "lake district." In ancient times there were forty-two divisions or nomes of Egypt, each having its own capital, local government, and *cultus*, and all more or less worshipping Osiris. From these the Fayûm was excluded. It was divided like the parent country into nomes with their governors, and save in the necropolis at Hawara was given over to the worship of Sebak, the crocodile god. It was known in the hieroglyphs as To She, the lake district, which in Coptic became P-ium, the maritime district, and survives to-day in the Arabic Fayûm. It is evident from the celebrated Fayûm papyrus, of which there are two copies, that the term Mer-uer, the great water or lake, was also applied to it; and perhaps herein lies the origin of the name "Mœris." The waters of this lake must have reached to the plateau of Hawara, the necropolis of the inhabitants of a town called Shed, on the site of which stands the modern city of Medinet-el-Fayûm. It was in ancient times a Royal residence, and contained a magnificent temple dedicated to Sebak, whose dimensions far exceeded those of the temples at Thebes. Tradition gives Amen-em-hat III. of the twelfth dynasty as the constructor of Lake Mœris, and his burial-place is the crude brick pyramid at Hawara; but fragments bearing the cartouches of Amen-em-hat I. and Usertsen II., found near Medinet, would prove it of more ancient date. Moreover, it was hardly possible that a town of such dimensions as Shed would be built at any distance from water. A canal named Hune, or Hunet, cut from the Nile, fed the lake and provided for the needs of the city; the mouth of it was called in the hieroglyphs La Hune, "the opening of the canal," a name which survives in the modern "El-Lahûn." There is an intetesting allusion to this "opening of the canal" in the celebrated Stela of Piankhi, written about the eighth century B.C. M. Brugsch also suggested that Ra-pa-ro-hunet, "the temple of the mouth of the canal," might give us the derivation of the word labyrinth.

WE have received the third number of *Natural Science*, the new monthly review of scientific progress. Among the contributors are Prof. G. Henslow, Mr. G. A. Boulenger, Sir J. W. Dawson, and Prof. W. C. Williamson.

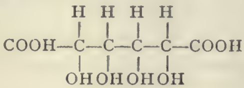
MESSRS. CHARLES GRIFFIN AND CO. have published the "Year-book of the Scientific and Learned Societies of Great Britain and Ireland." This is the ninth yearly issue. It presents lists of papers read before various Societies during the year 1891, together with information as to official changes. In most cases the Societies themselves have contributed the lists of papers. The names of those Societies concerning which no information has been received are entered in the index only.

Messrs. W. and A. K. Johnston have issued, under the authority of the Royal Agricultural Society of England, a valuable series of eight diagrams representing the life-history of the wheat plant. The diagrams are reproductions of original drawings by Francis Bauer, now in the Botanical Department of the British Museum, and are printed in colours. With each set is sent a pamphlet by William Carruthers, F.R.S., consulting botanist to the Society, entitled "The Wheat Plant: How it Feeds and Grows." This pamphlet consists of notes explanatory of the diagrams.

Dr. L. Meschinelli and Dr. S. Squinabol announce for publication a Tertiary Flora of Italy.

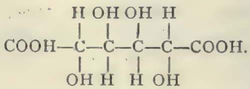
Four lectures upon recent stellar spectroscopy and the new star in Auriga will be delivered in Gresham College, by the Rev. Edmund Ledger, at 6 p.m. on the evenings of May 10, 11, 12, and 13.

Another contribution to our knowledge of the sugars and their related compounds is published by Prof. Emil Fischer in the current number of the *Berichte*. It relates to the constitution of the group of substances at the head of which stands dulcitol, $CH_2OH—(CHOH)_4—CH_2OH$, the hexahydric alcohol obtained from Madagascar manna, and prepared artificially by the reduction of milk sugar. It has already been established that the aldehyde corresponding to dulcitol is galactose, $CH_2OH—(CHOH)_4—COH$, the glucose obtained from many gums, and which is formed when milk sugar is boiled with dilute acids. Moreover, it has long been known that, when either dulcitol or galactose are oxidized by means of nitric acid, a dibasic acid of the composition $COOH—(CHOH)_4—(COOH)$ is produced. This acid, although expressed by the same formula as saccharic acid, the acid obtained by the oxidation of common cane-sugar, differs considerably in properties from that acid, and has been termed mucic acid. It is now known to be a geometrical isomer of saccharic acid—that is to say, the two compounds only differ with regard to the relative positions of the atoms comprising their molecules. Saccharic acid, as obtained from cane-sugar, is probably unsymmetrically built up, for its solution rotates the plane of polarization of light to the left. The main result of the work now described has been to show that the molecules of mucic acid are, on the contrary, symmetrically constructed, and that its observed optical inactivity is due to this fact. Theoretical considerations, based upon the postulates of the Van 't Hoff-Wislicenus hypothesis concerning the arrangement of carbon, hydrogen, and oxygen atoms in space, lead to the view that, of the ten possible geometrically-isomeric dibasic acids of the constitution $(CHOH)_4 . (COOH)_2$, two must be optically inactive. These two optically inactive isomers would be represented respectively by the formulæ



$$\mathrm{COOH{-}\underset{OH}{\overset{H}{C}}{-}\underset{OH}{\overset{H}{C}}{-}\underset{OH}{\overset{H}{C}}{-}\underset{OH}{\overset{H}{C}}{-}COOH}$$

and



$$\mathrm{COOH{-}\underset{OH}{\overset{H}{C}}{-}\underset{H}{\overset{OH}{C}}{-}\underset{H}{\overset{OH}{C}}{-}\underset{OH}{\overset{H}{C}}{-}COOH.}$$

One of these two was presumably mucic acid. It was evident that if the molecules possessed a configuration similar to that roughly indicated in one plane by either of the above formulæ, upon reduction to a monobasic acid there would be an equal number of chances of each of the two end carboxyl groups being attacked by the reducing agent and converted to CH_2OH groups. Consequently it was to be expected that equal quantities of two geometrically isomeric monobasic acids would be obtained, one dextro- and the other lævo-rotatory. Such has, indeed, been found by Prof. Fischer to be the case; for, upon reducing either the ethyl ester or the lactone of mucic acid (the acid itself being unattacked) by means of sodium amalgam, an optically inactive acid of the constitution $CH_2OH—(CHOH)_4—COOH$ was obtained, which formed a salt with strychnine yielding two distinct kinds of crystals, resembling the well-known complementary racemates of Pasteur. From these two kinds of crystals solutions of the free acids were obtained, which were respectively dextro- and lævo-rotatory, and each was again converted into mucic acid upon oxidation. One of these, the right-handed variety, was identical with the common galactonic acid prepared by oxidation of galactose. Moreover, by further reduction of the inactive acid, an inactive glucose was obtained, from which eventually common dextro- and also lævo-galactose were isolated by fermentation; and finally, by still further reduction of the galactose, dulcitol itself was obtained. Hence, the symmetrical structure of the dulcitol group may be considered as proved, and the work also completes the artificial synthesis of these compounds; for, given the synthesis of any one by the method previously described by Prof. Fischer, any of the others may be prepared from it by the processes now described.

The additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Miss Beatrice Raymond; a Wild Swine (*Sus scrofa* ♀) from Tangiers, presented by Mr. E. H. Banfather; a Great Kangaroo (*Macropus giganteus*) from Australia, presented by Mrs. Frazer; a Purple Heron (*Ardea purpurea*), European, presented by Captain Woodward; a Bateleur Eagle (*Helotarsus ecaudatus*), a Tawny Eagle (*Aquila nævioides*) from Africa, presented by Captain Webster; a Raven (*Corvus corax*), European, presented by Mr. F. J. Stokes; seven Common Vipers (*Vipera berus*), British, presented by Mr. T. A. Cotton, F.Z.S.; a Rufous-necked Weaver Bird (*Hyphantornis textor*) from West Africa, purchased; an English Wild Bull (*Bos taurus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Sun-spots.—In the March number of the *Memorie della Società degli Spettroscopisti Italiani*, there are some interesting notes relating to spots and prominences. Prof. Tacchini gives a tabulated statement of the solar observations made at the Royal Observatory for the last three months of the year 1891. The most frequent records of faculæ occurred in the zones ±10° ±30°, only one being seen as high as the zone +40° +50°. As regards the spots, the greatest frequency of groups took place in the zones ±10° ±20°, 23 and 10 being observed in the north and south respectively.

Profs. A. Mascari and J. Fenyi both contribute some notes on the large group of spots visible in February last, the latter pointing out that the relation of the eruption to the large group was such that its centre was situated very near the side of the great nucleus of the south spot, but was entirely outside the spot itself.

M. H. Deslandres records also his observations with respect to the remarkable protuberance visible on March 3 at about 10 a.m. From spectroscopic observations he obtained a radial velocity of 200 kilometres per second, using the hydrogen and helium lines. He also obtained a photograph of the invisible ultra-violet region, which furnished him with "an exact image" of this protuberance. The H and K lines were extraordinarily brilliant, and the negative contained the entire series of ultra-violet rays of hydrogen. It may be mentioned that at the appearance of this large protuberance no special indication was registered on the curves of the magnetic instruments which M. Deslandres obtained from M. Wolf.

Prof. Tacchini communicated to the Paris Academy on April 25 the results of solar observations made at the Roman College during the first three months of this year. Spots and faculæ were observed on 56 days, viz. 19 in January, 19 in February, and 18 in March. The results are shown below:—

1892.	Relative frequency of spots.	Relative frequency of days without spots.	Relative magnitude of spots.	Relative magnitude of faculæ.
January	19·63	0·00	79·79	56·58
February	23·31	0·00	153·61	60·28
March	13·12	0·00	61·67	86·39

The following are the results for prominences:—

1892.	Days of observation.	Mean number.	Mean height.	Mean extension.
			″	°
January	13	6·39	39·6	1·6
February	13	7·00	36·0	1·6
March	14	8·14	36·4	2·3

The frequency and magnitude of spots during these months are much greater than during the preceding quarter, but prominences do not show a marked increase. No augmentation of this class of phenomena appears to have accompanied the great spot of February, if the mean numbers for the month be taken.

ECLIPSE OF THE MOON, MAY 11.—A partial eclipse of the moon will occur on May 11, and, if weather permits, it should be widely observed. The magnitude of the eclipse is 0·953, the moon's diameter being represented by 1. But although it is not total, important naked-eye observations can be made on the darkness of the shadowed moon for comparison with previous eclipses, and possessors of telescopes will doubtless take advantage of the occasion to obtain some new facts. The following times are from the "Nautical Almanac":—

		G.M.T. h.	m.
First contact with the penumbra,	May 11	7	55·9
,, ,, ,, shadow	,,	9	10·2
Middle of the eclipse	,,	10	53·4
Last contact with the shadow	,,	12	36·6
,, ,, ,, penumbra	,,	13	50·9

The first contact with the shadow occurs at 82° from the most northern point of the moon's limb, counting towards the east; the last contact at 41° from the same point, counting towards the west.

SPECTRUM OF SWIFT'S COMET (*a* 1892).—Mr. W. W. Campbell observed the spectrum of Swift's comet on April 6, by means of a spectroscope having one prism of 60° attached to the 36-inch of the Lick Observatory (*Astronomical Journal*, No. 262). The spectrum could be distinguished from about C to G. Three bright bands had the wave-lengths of their less refrangible edges determined as 5630, 5170·4, and 4723, by comparison with spark-spectra of iron and magnesium. The intensities of the bands were estimated to be in the ratio 1 : 6 : 2.

COMET SWIFT, 1892.—*Astronomische Nachrichten*, No. 3087, contains the following ephemeris of Swift's comet:—

For 12h. Berlin Mean Time.

1892.	R.A. h.	m.	s.	Decl. °	′	log *r*.	log Δ.	B.
May 5	22	45	25	+23	41·7			
,, 6	22	48	19	24	21·5			
,, 7	22	51	12	25	0·5	0·0608	0·1115	0·70
,, 8	22	54	3	25	38·7			
,, 9	22	56	53	26	16·2			
,, 10	22	59	41	26	52·9			
,, 11	23	2	28	27	28·9	0·0723	0·1236	0·62

The brightness on March 10 is taken as unity.

On the 5th the comet will be found to form very nearly an equilateral triangle with the stars λ and μ in Pegasus, while on the 11th it will be near β in the same constellation.

COMET SWIFT, 1892.—The spectrum of this comet has been observed by Prof. Konkoly, who contributes his observations to the *Astronomische Nachrichten*, No. 3087. The spectrum on April 1 appeared very bright, and showed five bright lines whose intensities were as follows:—I. = 0·4; II. = 0·3; III. = 1·0; IV. = 0·2; V. = 0·1, the continuous spectrum extending from λ = 580 to λ = 440.

The following measures are the means of five direct scale readings of the above-mentioned lines:—

I. = 558·82 μμ
II. = 544·94
III. = 516·30
IV. = 472·54
V. = 468·78

Similar observations were also repeated the next night, only by means of a larger telescope and spectroscope. The continuous spectrum was found to extend from λ = 559 μμ to λ = 449 μμ. The intensities were I. = 0·5; II. = 0·3; III. = 1·0; IV. = 0·2; V. = 0·1.

The mean values of the five measures obtained for each line were:—

I. = 558·40 μμ
II. = 543·82
III. = 516·26
IV. = 472·70
V. = 468·10

NOVA AURIGÆ.—*Astronomische Nachrichten*, No. 3083, contains some measurements and remarks by Prof. Konkoly relative to the spectrum of this Nova. Five lines were, according to him, very satisfactorily measured on March 20, and the means of six measures for each were as follows:—

I. = 531·80 μμ
II. = 516·50
III. = 501·95
IV. = 492·30
V. = 486·15

Using a 10-inch objective prism on the 21st, he found that II. was the brightest line, III. being somewhat feebler; I. was very weak, while IV. was not bright, but broad; V., again, seemed quite visible. With regard to the dark lines, he was only able to suspect them in the region of C and F (especially the latter), owing to their feebleness. The hydrogen lines on the 21st appeared feebler than those in γ Cassiopeiæ.

A NEW VARIABLE.—A circular (No. 32) that we have received from the Wolsingham Observatory contains the following:—

The star D.M. + 55° 1870—

16h. 39m. 49s.; + 55° 12′; 9·2

was found 7·3; 7·7, April 26; 29. Variable. Spectrum like Mira.

T. E. ESPIN.

THE TEMPERATURE OF THE BRAIN.

THE Croonian Lecture was delivered this year by Prof. Angelo Mosso, Professor of Physiology in the University of Turin. His subject was the temperature of the brain, especially in relation to psychical activity. Prof. Mosso's earlier investigations on the human brain only related to the blood circulation.[1] He then found that the blood pressure rises during psychical work, and that during such more blood is sent from the peripheral parts of the body. Prof. Mosso also found that the blood circulation in the brain showed fluctuations which are not dependent on psychical activity. These and other variations in the brain circulation led him to suspect that Dr. Schiff's theory about brain temperature as introduced into physiology required revision. In a published work on fatigue,[2] Prof. Mosso gave his views on the influence of psychical work on the organism, especially on the muscular force. We do not yet know what form of phenomena subserves the first condition of thought. Fatigue caused by psychical activity acts as a poison, which affects all organs, but especially the muscular system. This is clearly demonstrated by Prof. Mosso's investigations on men who have been subjected to great mental strain. The blood of dogs, fatigued by long racing, acts as a poison, and when injected into other dogs they exhibit all the symptoms of fatigue. The characteristic phenomena of fatigue depend more on nerve-cell products than on a deficiency of suitable material.

During investigation into the physical conditions during psychical activity, Prof. Mosso's attention was directed to the subject of the temperature of the brain. To avoid errors arising from blood changes he endeavoured to keep the blood temperature and that of the organs in agreement with that of the brain. For such a purpose he found that the thermo-electric pile which Dr. Schiff employed would not suffice, and he had therefore made by Baudin, of Paris, some very sensitive mercurial thermometers. The investigations made with the help of these instruments on the brain and blood temperatures bring to light new evidences of activity in the nerve centres. There are sometimes very extensive temperature developments under the influence of special excitements quite independent of psychical activity. The change in the nutrition of the nerve-cells, and not their specific activity, seems to be the most important source of heat in the brain. Thus Prof. Mosso would explain the marked effect on brain temperature of ordinary irritants where the increase is far higher upon the introduction of such than upon any psychical work done by the brain.

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[1] "Kreislauf des Blutes in menschlichen gehirne," Leipzig, 1881.
[2] "Die Ermudung," Leipzig, 1892.

The following is an abstract of Prof. Mosso's Croonian Lecture:—

In his investigations on the temperature of the brain the author has employed, in preference to the thermo-electric pile, exceedingly sensitive mercurial thermometers, constructed specially for the purpose. Since each thermometer contains only four grams of mercury, the instruments respond very rapidly to changes of temperature, and a change of not more than 0°·002 C. can easily be measured by means of them. The author has studied the temperature of the brain, comparing it with that of arterial blood, of the muscles, and of the interior of the body. His observations were made on animals under the influence of morphia or various anæsthetics, and also on man.

The curves of the observations made show that in profound sleep a noise, or other sensory stimulus, is sufficient to produce a slight development of heat in the brain, without the animal necessarily awakening.

In profound sleep the temperature of the brain may fall below that of the blood in the arteries. This is due to the very great radiation of heat which takes place from the surface of the head.

The brain when subjected to the action of the ordinary interrupted current rises in temperature. The rise is observed earlier in the brain than in the blood, and the increase is greater in the brain than in the general blood-current or in the rectum. During an epileptic seizure, brought on by electrical stimulation of the cerebral cortex, the author observed within twelve minutes a rise of 1° C. in the temperature of the brain.

As a rule the temperature of the brain is lower than that of the interior of the body; but intense psychical processes, or the action of exciting chemical substances, may cause so much heat to be set free in the brain that its temperature may remain for some time 0°·2 or 0°·3 C. above that of the interior of the body.

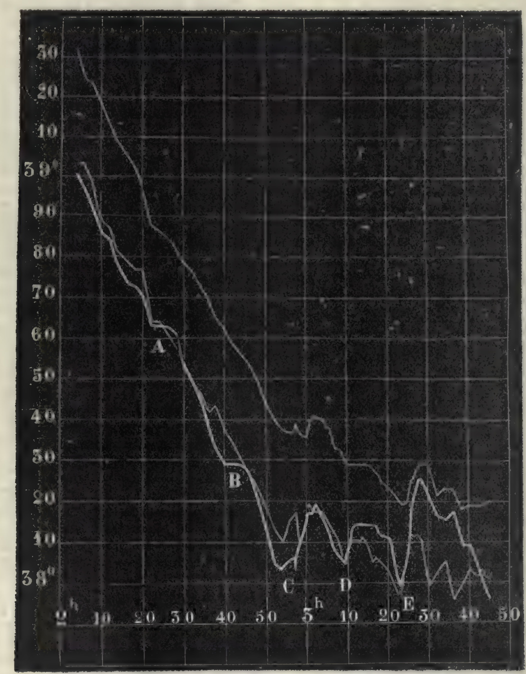


Fig. 1.—Dog rendered insensible with laudanum. The upper (thin) line represents the temperature of the interior of the body, the middle (thin line the temperature of the blood in the carotid artery, the third (thick) line the temperature of the brain. A, injection of 3 c.c. laudanum; B, blast of a trumpet; C, D, E, electric stimulation of the brain. The ordinate is marked in tenths of a degree Centigrade, the abscissa in periods of ten minutes.

When a dog is placed under the influence of curare, the temperature of the brain remains fairly high, while that of the muscles and that of the blood falls. The difference of temperature thus brought about is great and constant. In one instance, the temperature of the brain was 1°·6 C. above that of the arterial blood in the aorta. Such observations warn us not to regard the muscles as forming, *par excellence*, the thermogenic tissue of the body.

In order to show how active are the chemical processes in the brain, it is sufficient to keep the animal in a medium whose temperature is the same as that of the blood. When the effects of radiation through the skull are thus obviated, the temperature of the brain is always higher than that of the interior of the body, the difference amounting to 0°·5 or 0°·6 C.

Observations made while an animal is awake tend to show that the development of heat due to cerebral metabolism may be very considerable, even in the absence of all intense psychical activity. The mere maintenance of consciousness belonging to the wakeful state involves very considerable chemical action.

The variations of temperature, however, observed in the brain, as the result of attention, or of pain or other sensations, are exceedingly small. The greatest rise of temperature observed to follow, in the dog, upon great psychical activity was not more than 0°·01 C. When an animal is conscious, no change of consciousness, no psychical activity, however brought about experimentally, produces more than a slight effect on the temperature of the brain.

The author shows an experiment by which it is seen that, as part of the effect of opium, the brain is the first organ to fall in temperature, and that it may continue to fall for the space of eighteen minutes, while the blood and the vagina are still rising in temperature.

The author discusses the elective action of narcotics and anæsthetics. He shows that these drugs suspend the chemical functions of the nerve-cells. In a dog rendered completely insensible by an anæsthetic, one no longer obtains a rise of temperature upon stimulating the cerebral cortex with an electric current. These results cannot be explained as merely due to the changes in the circulation of the blood. The physical basis of psychical processes is probably of the nature of chemical action.

In another experiment, in an animal rendered insensible with chloral, the curves of temperature show that when the muscles of a limb are made to contract, the temperature of the muscles rises, but falls rapidly as soon as the stimulation ceases, soon returning to the normal. This is not the case, however, with the brain excited by an electric current. Here the stimulus gives rise to a more lasting production of heat; the temperature may continue to increase for several minutes after the cessation of the stimulation, indeed, often for half an hour. This may possibly explain why, upon an electric stimulation of the cerebral cortex, the epileptiform convulsions are not immediately developed, but only appear after the lapse of a latent period of several minutes.

This experiment may be made to show the elective action exercised upon the brain by stimulant remedies. The injection of 10 centigrams of cocaine hydrochlorate produces a rise of

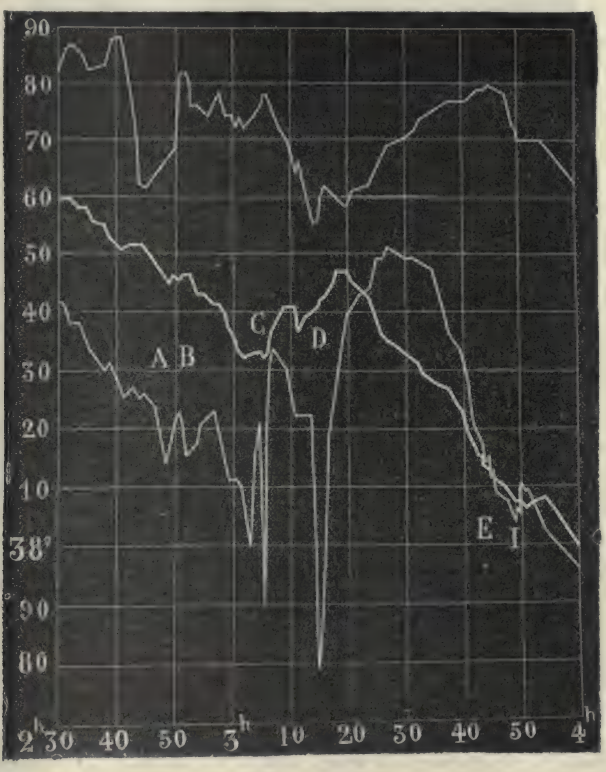


FIG. 2.—Dog (female) rendered insensible with chloroform and then with laudanum. The upper line represents the temperature of the vagina, the middle (thicker) line that of the brain, the lower that of the arterial blood in the carotid artery. A and B, psychical emotion; C, electric stimulation of the brain; D, injection of 14 c.c. laudanum (intravenous); E and I, electric stimulation of the brain.

temperature in the brain of 0°·36 C., without any change in the temperature of the muscles or of the rectum being observed. In a curarised dog, the intervention of the muscles being thereby excluded, the action of the cocaine may produce a rise of as much as 4° C. in the temperature of the brain, the author having observed a rise from 37° to 41° C. This shows that in arranging the calorific topography of the organism a high place must be assigned to the brain.

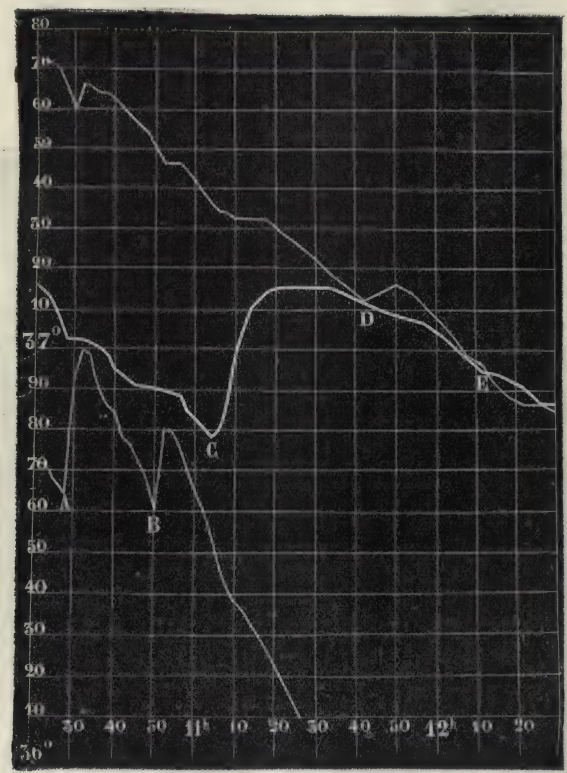


Fig. 3.—Dog rendered insensible with chloral. The upper line represents the temperature of the rectum, the middle (thicker) line that of the brain, the lower line that of the muscles of the thigh. A and B, electric stimulation of the muscles; C, injection of 10 centigrams of cocaine int the saphena vein; D, E, spontaneous variations in the temperature of the rectum.

THE MAGNETIC STORM OF FEBRUARY IN MAURITIUS.

At a meeting of the Meteorological Society of Mauritius, that took place on April 7, Mr. Meldrum read a short paper on the sun-spots, magnetic storm, cyclones, and rainfall of February 1892. The photographs of the sun that he exhibited, which were taken at the Royal Alfred Observatory from February 5 to 18, showed the very large group of spots, their approximate latitude on the 9th being from 6° to 16° south. Leading on to the occurrence of the great magnetic storm which began at 8h. 55m. on the 13th, he states that its commencement was distinctly recorded on the three curves, the horizontal force suffering the greatest disturbance. Up to 14h. the magnet was in oscillation, the force increasing, and reaching a maximum at 13h. 43m., after which it began to decrease, the minimum being reached at 0h. 15m. on the 14th. Further abrupt movements occurred at 4h. 30m. on the 14th, the oscillations, as shown by the curves, being very numerous, but at 19h. the magnets became more steady, and were quiet by 3h. on the 15th. The ranges obtained at the Mauritius Observatory were the largest ever recorded there.

Cyclones were not absent during this month. One lasted from the 11th to the 14th, and another from the 25th to the 28th, while a third was also experienced on the 21st and 22nd, about 550 miles south of Mauritius. The rainfall for February, as shown by returns from the numerous stations, was from 4·30 to 16·96 inches above the average for periods of 7 to 29 years. At Antoinette the fall for the month amounted to 12·53 inches, while that at Cluny came to 34·37 inches. St. Aubin and Nouvelle France came in for a considerable quantity of rain, the falls in the 24 hours ending at 8 a.m. on the 13th reaching the figures 5·00 and 18·20 inches respectively. Referring lastly to the magnificent displays of auroræ that have been observed both in Europe and America, he mentions that, although at Mauritius the sky was overcast, under similar conditions with respect to solar activity and terrestrial magnetism, a great display was visible in 1872. Mr. Meldrum, in his concluding remarks as to whether "there is a causal connection between solar activity (as indicated by outbursts on the sun) and magnetic disturbances, auroras, cyclones, and rainfall," remarks that with regard to the two former there can hardly be any doubt, but with regard to the two latter he is of opinion that a very close connection does exist, there being a considerable preponderance of evidence in its favour.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—*Annual Abstract of Accounts.*—The abstract of accounts of the University for the year ending December 31, 1891, has just been published. It exhibits both the accounts of the Curators of the Chest and the financial position of the University institutions. The receipts show an income of £66,986 12*s.* 9*d.*, against £65,175 17*s.* 2*d.* last year. The principal sources of internal income include estates £9978 12*s.* 8*d.*, the University Press £5000, University dues £11,153 5*s.*, examination fees £5659 1*s.*, degree fees £9600. The Proctorial fines amount to only £313, nearly £100 less than last year. In connection with the present agitation against Proctorial jurisdiction this item is interesting. The total payments amounted to £64,557 6*s.* 3*d.* There was transferred to capital account £2225 16*s.* 4*d.*, and a balance carried forward of £203 10*s.* 2*d.* In this item of expenditure, we find institutions and public buildings cost £19,085, the largest item under this head being the Bodleian Library £7772 4*s.* 4*d.*, while the Taylor Institution absorbed £2245. The expenses in connection with lectures in large towns amounted to £729 11*s.* 8*d.*, and the interest and sinking fund on loans for University purposes came to £6157 8*s.* 4*d.*

The loans account shows that the amounts remaining to be paid are £36,000 at 4 per cent. on the £60,000 New Schools Loan, and £7666 13*s.* 4*d.* at 2¾ per cent. on the £10,000 Physiological Laboratory Loan.

The University and the County Councils.—The report on the peripatetic teaching in scientific and technical subjects carried on in various country districts under the supervision of the Oxford Delegates for University Extension, acting in concert with the Technical Instruction Committees of County Councils during last winter, has just been published. The report states that the Oxford Delegates for University Extension were requested by the representatives of eight County Councils in England to provide for the delivery of 227 courses, embracing 2271 lectures, on chemistry, agriculture, geology, botany, veterinary science, physiology, and hygiene. These courses have been regularly attended by more than 10,000 persons in all grades of society.

The relations between the University Extension Committees of the different Universities and the County Councils, in reference to the matter of technical instruction, has now become so important, that a Conference was summoned last week, under the presidency of the Provost of Queen's College, to consider this connection, and to profit by the experience already gained, an experience, which in some cases extends over two years. It was felt that there are certain mistakes, inevitable in the commencement of any large scheme, which might be advantageously removed, so as to promote greater harmony, and possibly more economy in the fuller development of the scheme. Many organizing secretaries and others interested in the scheme attended the Conference, which extended over two days.

Two principal subjects were under discussion, first, the provision of summer courses of instruction in Oxford, Cambridge, and other University towns for teachers in elementary schools; secondly, the methods of organization of peripatetic teaching in regard to hours of lectures, classes, cost, and local management. In connection with the first point, it was announced that Oxford, Cambridge, and the Yorkshire College, Leeds, would be prepared to offer accommodation to students this summer; the Victoria University has, however, made no such provision. The method of procuring instruction in practical agriculture and experimental farming occupied much of the attention of the meeting, and much stress was laid upon the importance of securing the co-operation of farmers to look after the experimental stations.

On the matter of peripatetic teaching, it was felt by some that no very great assistance could be expected from the elementary teacher, and that reliance must be placed upon the teacher supplied by the Universities, in some cases advantageously supplemented by the teachers in secondary schools.

Not the least important feature in the Conference was the anxiety displayed by all present to urge on to the utmost of their power the great work of the dissemination of technical and scientific instruction, influenced solely by disinterested motives for the public service.

CAMBRIDGE.—Prof. Bonney, F.R.S., Fellow of St. John's College, will this year deliver the Rede Lecture in the Senate House, on Wednesday, June 15, at noon. The subject is "The Microscope's Contributions to the Earth's Physical History."

The Adams Memorial Committee have issued a circular inviting contributions towards the erection of a monument to the late Prof. J. C. Adams in Westminster Abbey. These may be paid to one of the treasurers (Dr. Searle, Master of Pembroke, and Prof. Liveing), or to one of the secretaries (Dr. Porter, Master of Peterhouse, Dr. Donald MacAlister, St. John's, and Dr. Glaisher, Trinity), or to the account of the Adams Memorial Fund at Messrs. Mortlock's Bank, Cambridge. We do not doubt that the invitation will meet with a generous response from the admirers of the great astronomer.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 28.—"On a Decisive Test-case disproving the Maxwell-Boltzmann Doctrine regarding Distribution of Kinetic Energy." By Lord Kelvin, Pres. R.S.

The doctrine referred to is that stated by Maxwell in his paper "On the Average Distribution of Energy in a System of Material Points" (Camb. Phil. Soc. Trans., May 6, 1878, republished in vol. ii. of Maxwell's "Scientific Papers") in the following words:—

"In the ultimate state of the system, the average kinetic energy of two given portions of the system must be in the ratio of the number of degrees of freedom of those portions."

Let the system consist of three bodies, A, B, C, all movable only in one straight line, KHL:

B being a simple vibrator controlled by a spring so stiff that when, at any time, it has very nearly the whole energy of the system, its extreme excursions on each side of its position of equilibrium are small:

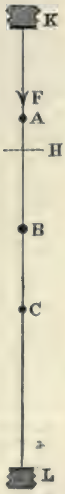
C and A, equal masses:

C, unacted on by force except when it strikes L, a fixed barrier, and when it strikes or is struck by B:

A, unacted on by force except when it strikes or is struck by B, and when it is at less than a certain distance, HK, from a fixed repellent barrier, K, repelling with a force, F varying, according to any law, or constant, when A is between K and H, but becoming infinitely great when (if at any time) A reaches K, and goes infinitesimally beyond it.

Suppose now A, B, C to be all moving to and fro. The collisions between B and the equal bodies A and C on its two sides must equalize, and keep equal, the average kinetic energy of A, immediately before and after these collisions, to the average kinetic energy of C. Hence, when the times of A being in the space between H and K are included in the average, the average of the *sum of the potential and kinetic energies of* A is equal to the average kinetic energy of C. But the potential energy of A at every point in the space HK is positive, because, according to our supposition, the velocity of A is diminished during every time of its motion from H towards K, and increased to the same value again during motion from K to H. Hence, the average kinetic energy of A is less than the average kinetic energy of C!

This is a test-case of a perfectly representative kind for the theory of temperature, and it effectually disposes of the assumption that the temperature of a solid or liquid is equal to its average kinetic energy per atom, which Maxwell pointed out as a consequence of the supposed theorem, and which, believed to be thus established, has been largely taught, and fallaciously used, as a fundamental proposition in thermodynamics.



It is, in truth, only for an approximately "perfect" gas—that is to say, an assemblage of molecules in which each molecule moves for comparatively long times in lines very approximately straight, and experiences changes of velocity and direction in comparatively short times of collision—and it is only for the kinetic energy of the translatory motions of the molecules of the "perfect gas," that the temperature is equal to the average kinetic energy per molecule, as first assumed by Waterston, and afterwards by Joule, and first proved by Maxwell.

"Researches on Turacin, an Animal Pigment containing Copper; Part II." By A. H. Church, M.A., F.R.S., Professor of Chemistry in the Royal Academy of Arts, London.

This paper is in continuation of one read before the Society in May 1869 (Phil. Trans., vol. clix. pp. 627–36). It contains an account of observations made by other investigators on turacin and on the occurrence of copper in animals; a table of the geographical distribution of the Touracos, and a list of the twenty-five known species; a chart of turacin spectra (for which the author is indebted to the kindness of Dr. MacMunn); and a further examination of the chemical characters and the composition of turacin. The more important positions established by the present inquiry are these:—

1. The constant occurrence in eighteen out of the twenty-five known species of *Musophagidæ*, of a definite organic pigment containing, as an essential constituent, about 7 per cent. of copper.

2. The "turacin-bearers" comprise all the known species of the three genera, *Turacus*, *Gallirex*, and *Musophaga*; while from all the species of the three remaining genera of the family *Musophagidæ*—namely, *Corythæola*, *Schizorhis*, and *Gymnoschizorhis*—turacin is absent. Furthermore, the zoological arrangement of the genera constituting this family is in accord with that founded on the presence of turacin.

3. The spectrum of turacin in alkaline solution shows, besides the two dark absorption bands previously figured, a faint broad band on either side of line F, and extending from λ 496 to λ 475.

4. The spectrum of *isolated* turacin in ammoniacal solution shows, besides the three bands already named, a narrow fourth band, lying on the less-refrangible side of line D, and extending from λ 605 to λ 589. It probably arises from the presence of traces of the green alteration-product of turacin formed during the preparation of that pigment in the isolated condition; an alteration-product which is likely to prove identical with Krukenberg's turacoverdin.

5. Turacin in ammoniacal solution remains unchanged after the lapse of twenty-three years.

6. Turacin in the dry state, when suddenly and strongly heated, yields a volatile copper-containing red derivative, which, though undissolved by weak ammonia-water, is not only soluble in, but may be crystallized from, ether.

7. Turacin in the dry state, when heated in a tube surrounded by the vapour of boiling mercury, becomes black, gives off no visible vapour, is rendered insoluble in alkaline liquids, and is so profoundly changed that it evolves no visible vapour when afterwards strongly heated.

8. The accurate analysis of turacin offers great difficulty. The percentage composition, as deduced from those determinations which seem most trustworthy, is—

Carbon	53·69
Hydrogen	4·60
Copper	7·01
Nitrogen	6·96
Oxygen	27·74

These numbers correspond closely with those demanded by the empirical formula $C_{82}H_{81}Cu_2N_9O_{32}$, although the author lays no stress upon this expression.

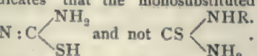
9. Turacin presents some analogies with hæmatin, and yields, by solution in oil of vitriol, a coloured derivative, turacoporphyrin. The spectra of this derivative, both in acid and alkaline solution, present striking resemblances to those of hæmatoporphyrin, the corresponding derivative of hæmatin. But copper is present in the derivative of turacin, while iron is absent from its supposed analogue, the derivative of hæmatin.

Chemical Society, April 7.—Dr. W. H. Perkin, F.R.S., Vice-President, in the chair.—The following papers were read:—The separation of arsenic, antimony, and tin, by J. Clark. The mixed sulphides of arsenic, antimony, and tin obtained in the ordinary course of quantitative analysis are dissolved in a strong solution of ferric chloride in hydrochloric acid, and the arsenic distilled off and weighed as trisulphide. The residual liquor contains the antimony as trichloride, and the tin as stannic chloride, together with ferrous and ferric chlorides. Without removing the iron salts, the antimony is precipitated with hydrogen sulphide in a tepid solution containing from one-quarter to one-third of its volume of hydrochloric acid and a considerable quantity of oxalic acid. The precipitate, which is free from tin, is washed first with water, then with alcohol, and finally with carbon disulphide, and weighed as Sb_2S_3 after being dried at 130°. When the antimony precipitate is large, it must, after drying, be digested in carbon disulphide to extract the whole of the sulphur. To obviate this, the author reduces the excess of ferric chloride with thin sheet-iron, as soon as the yellow colour has disappeared the undissolved iron is removed, and the antimony which has come down is redissolved by cautiously adding ferric chloride till the solution is distinctly yellow, showing that all the tin is in the stannic state; a warm solution of oxalic acid containing about one-third of its volume of hydrochloric acid is then added, and the precipitated antimony trisulphide washed and weighed as above. After removal of the antimony, the hydrogen sulphide is expelled by boiling, the oxalic acid decomposed with potassium permanganate, the tin precipitated in a hot solution with hydrogen sulphide, and allowed to stand till cold. The stannic sulphide thus obtained is filtered, washed, ignited, and weighed as SnO_2.—Platinous chloride and its use as a source of chlorine, by W. A. Shenstone and C. R. Beck. The authors have examined chlorine prepared from six specimens of platinous chloride of independent origin, and have found oxygen and hydrogen chloride to be present in them all. From these results they conclude that platinous chloride made by any of the processes hitherto recommended, including that lately suggested by L. Pigeon, contains a very perceptible quantity of some basic compound, which gives off water, together with the gases previously mentioned. It was also noticed that after mercury has been exposed to the action of chlorine, in the presence of a trace of water, it becomes capable of absorbing hydrogen chloride; it is not yet certain whether this action depends on the presence of oxygen or not.—Note on the adhesion of mercury to glass in the presence of halogens, by W. A. Shenstone. The author finds that carefully purified chlorine, bromine, and iodine affect mercury like ozone, causing it to adhere to glass in a remarkably perfect manner.—The decomposition of mannitol and dextrose by the *Bacillus ethaceticus*, by P. F. Frankland and J. S. Lumsden. The authors find that the products of fermentation of both mannitol and dextrose by *B. ethaceticus* consist of ethyl alcohol, acetic acid, carbon dioxide, hydrogen, and traces of succinic acid. A considerable quantity of formic acid is also formed when the fermentation proceeds in a closed space, whilst, in fermentations conducted in flasks merely plugged with cotton wool, formic acid, except in traces, is an exceptional product. This phenomenon has previously been found to occur with fermentations by means of *B. ethacetosuccinicus*. Formic acid is doubtless a primary product of the fermentation, but tends to break down into carbon dioxide and hydrogen. In the closed space, however, equilibrium is soon established between the formic acid and its decomposition products, and part of the formic acid is subsequently found in the solution. This view is supported by the fact that carbon dioxide and hydrogen are found in almost equal volumes. The proportions in which the several products are obtained from mannitol are approximately represented by the equation—

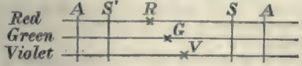
$$3C_6H_{14}O_6 + H_2O = C_2H_4O_2 + 5C_2H_6O + 5CH_2O_2 + CO_2.$$

In the case of dextrose the products occur in the proportions: $2{\cdot}5C_2H_6O : 1{\cdot}5C_2H_4O_2 : 3CH_2O_2 : CO_2$. There is a close qualitative and quantitative resemblance between fermentations by *B. ethaceticus* and those occurring by means of the *Pneumococcus* (Friedländer), which renders it probable that this ethacetic decomposition is a very general and typical form of fermentative change.—The preparation of glycollic acid, by H. G. Colman. Glycollic acid may be readily prepared by boiling concentrated potassium chloracetate solution for 24–30 hours. The liquid is then distilled under reduced pressure, and the residue mixed with acetone. On evaporation of the filtered solution, glycollic acid crystallizes out in colourless crystals, containing only about 0·5 per cent. of ash. This acid would seem to be dimorphous. Glycollic anilide may be prepared by heating glycollic acid for some time to 240°, and boiling the product with aniline.—Researches on silicon compounds and their derivatives; Part vi. The action of silicon tetrachloride on substituted phenylamines, by J. E. Reynolds. Diphenylamine combines with silicon tetrachloride to form an unstable addition compound, which is decomposed below the boiling-point of benzene. Ethylaniline is easily acted on by the tetrachloride, ethylaniline hydrochloride separates, and a compound having the composition $Si(PhNEt)_4$ is formed. Diethylaniline is but feebly acted on by silicon tetrachloride; the compound $PhNEt_2HCl$ is formed, and probably a substance of the composition $Si(C_6H_4NEt_2)_4$.—Chemistry of the compounds of thiourea and thiocarbimides with aldehyde-ammonia, by A. E. Dixon. The alkyl and allied thiocarbimides react with aldehyde-ammonia, in accordance with the following equation—

$$R.NCS + 2R'CH(OH)NH_2 = CSN_3H_2R(CHR')_2 + 2H_2O.$$

It was suggested that some connection might exist between the class of substances so formed and the compounds obtained by the action of thiourea on the aldehyde-ammonias. From the great similarity in behaviour of the compounds derived from the two sources, the author infers that they are members of the same class. Though thiourea and aldehyde-ammonia readily interact, it was found impossible, under any conditions, to cause substituted thioureas to act on aldehyde-ammonia. The author considers that this fact indicates that the monosubstituted thioureas are of the form  $HN:C\begin{cases}NH_2\\SH\end{cases}$ and not $CS\begin{cases}NHR.\\NH_2\end{cases}$. —The atomic weight of boron, by J. L. Hoskyns-Abrahall. The deceased author determined the atomic weight of boron by estimating the amount of silver necessary to precipitate the bromine from a known weight of boron bromide. The mean atomic weight obtained is 10·816 ± 0·0055. Silver is taken as 107·923, and bromine as 79·951.

Physical Society, April 8.—Dr. J. H. Gladstone, F.R.S., Past President, in the chair.—Mr. Walter Baily read a paper on the construction of a colour map. By the term "colour map," the author meant a diagram, each point of which defines by its position some particular colour. Captain Abney had shown that all colours, except the purples, could be formed by adding white light to some spectrum colour, whilst all except the greens could be made to produce white by the addition of some spectrum colour. There were, therefore, two ways in which colours, other than greens and purples, could be indicated. In one of these, the ordinate of a point might represent the spectrum colour by its wave-length, and the abscissa, measured to the right of a vertical spectrum line, the amount of white light to be added to the spectrum colour to produce the colour represented by the point. In the other, the abscissa of a point situated on the left of the spectrum line represents the quantity of white light produced by the addition of the spectrum colour to the colour indicated by the point. Regarding the spectrum colours as formed by mixing three primary colours (red, green, and violet) in varying proportions, three curves were drawn to the left of the spectrum line whose abscissæ represented respectively the proportions of the three primary colours present in the corresponding spectrum colour. Horizontal distances from any point to these curves show the proportions in which the primary colours are to be mixed produce to the particular colour defined by that point. For points between the curves, the horizontal distances are not measured all in one direction, and therefore indicate abnormal or imaginary colours. The principle of the map was further illustrated by a sort of colour staff, consisting of three horizontal lines representing the three primary colour sensations (see figure) of such luminosities that equal lengths of the three lines indicate white light. If points, R, G, V, be taken in these lines, then a cross line A will cut off lengths A R, A G, A V, whose mixture will produce a certain colour. If now A be moved parallel to itself towards the right, the colour will change by the addition of white light; moving A to the left means a subtraction of white light. When R, G, and V are properly chosen, a certain position, S, of the cross line, corresponds to a spectrum colour. The whole of the series of colours which can be obtained by adding white light to that spectrum colour can then be represented by sliding A towards the right. Positions S′ and A′ give colours complementary to S and A. The distinguishing features of such a series of colours are the differences R − G and G − V, and the author calls the ratio $\frac{R-G}{G-V}$ the "colour index." Passing up the spectrum from red to violet, the index, which is first large and positive, diminishes and becomes negative between yellow and blue; it then passes through infinity, and becomes positive and decreases to zero. The subject of determining the indexes of colours resulting from the mixture in various proportions of two other colours whose indexes were known, was considered, and diagrams showing the various curves, exhibited. Experimental methods of determining the proportions of the primary colour sensations constituting the spectrum tints were described. A visitor inquired how the author's system provided for the class of colours outside the red and violet. He also desired a definition of "white light." He himself had never been able to produce pure white by mixture of colours, for a reddish violet generally resulted. On the other hand, he found it possible to match any other colour by mixture. Prof. Carey Foster thought Helmholtz was the first to propound the law which the author had attributed to Captain Abney. He wished to know how the amounts of colour sensation were supposed to be measured. White light he considered ought to be defined as light in which a normal eye, not fatigued, could perceive no preponderance of any colour. Mr. Blakesley said that if white light was a mixture, and only two unknowns were necessary, then any colour could be produced by the mixture of two other colours. Dr. Sumpner pointed out that white light was by no means a constant colour, but depended greatly on the source. He thought the author's map of a more absolute nature than that proposed by Maxwell. Dr. Hoffert inquired whether the intensities of each spectrum colour had been considered equal or otherwise taken into account, and also whether the results arrived at would be true for intensities other than those chosen. Mr. Baily, in reply, said Captain Abney had found the light from the crater in the positive carbon of an electric arc to be the most constant white, and in his method of experimenting errors due to variations of the source cancelled. The quantity of any spectrum colour was defined by the breadth of the band used, the breadth being small and measured on the scale of wave-lengths.—A paper on a mnemonic table for changing from electro-static to practical and C.G.S. electro-magnetic units was read by Mr. W. Gleed. In the table, which is given below, the abbreviations *Stat* and *Mag* are used to denote the electro-static and electro-magnetic units respectively, and v stands for 3×10^{10}:—



	Units of				
	Capacity.	Resistance.	Potential.	Current.	Quantity.
Powers of 10 for practical and magnetic units	9	9	8	1	1
Small unit	Stat	Mag	Mag	Stat	Stat
Practical unit	Farad	Ohm	Volt	Ampere	Coulomb
Large unit	Mag	Stat	Stat	Mag	Mag
Factor for Stat and Mag	v^2	v^2	v	v	v

To form the table, the numbers 981 in the middle of the second line give the value of g. The end numbers are duplicated, giving 99,811. Below them in the fourth line come the names of the practical units, the initials forming the word *fovac*. Remembering that the electro-magnetic units of resistance and potential were too small for practical use, one places Mag above both Ohm and Volt. Ohm's law and definitions then show that the practical units of capacity, current, and quantity must be less than the electro-magnetic units, hence Mag must be written below Farad, Ampere, and Coulomb. Since the practical units are intermediate in magnitude between Stat and Mag, the vacant spaces are then filled in by Stat. The v's in the bottom line are added from memory. Several examples showing the use of the table are worked out in the paper accompanying the table.—A paper on the law of colour in relation to chemical constitution, by William Akroyd, was read by Mr. Blakesley. The author has observed that, in cases of compounds having a constant radical, R, and a variable radical R′, the effect of an increase in the molecular weight of R is to make the colour of the compound tend towards the red end of the colour scale. Exceptions are, however, noted. Mr. H. M. Elder questioned the author's conclusions, saying that in many cases the colours tend towards blue.

Anthropological Institute, April 26.—Dr. Edward B. Tylor, F.R.S., President, in the chair.—Prof. R. K. Douglas read a paper on the social and religious ideas of the Chinese, as illustrated in the ideographic characters of the language. The paper begins with a short introduction, showing that the Chinese ideographic characters are picture-writings, and that as such they supply an interpretation of the meaning of words as these were understood by the inventors of the characters representing them. Following on this is an account of the earliest or hieroglyphic form of the writing, with examples, and the development of this resulting in the ideographic characters. These are taken as being illustrative of the ideas of the people on political, social, scientific, and religious ideas. For example, the importance which was attached to the qualities of a sovereign is exemplified in the choice of the symbol employed to express a supreme ruler, the component parts of which together signify "ruler of himself." By means of the same graphic system a kingdom is shown as "men and arms within a frontier." Passing to the social habits of the people, their domestic life is illustrated by a number of ideograms descriptive of their household arrangements and relationships. In succession are traced in the written characters the ideas associated with men and women, their virtues and their failings; the notions associated with marriage; and the evidences of pastoral as well as of agricultural habits among the people. Turning to the popular religious faiths it is shown how prominent is the belief in the god of the soil, whose presence brings blessings, and whose averted countenance is followed by misfortune. The ideas associated with objects of nature are next treated of, and the paper concludes with references to the coinage of the country as described in the ideograms employed to represent its various forms.—Mr. Joseph Offord, Jun., read a paper on the mythology and psychology of the ancient Egyptians.

Entomological Society, April 27.—Mr. Robert McLachlan, F.R.S., Treasurer, in the chair.—Mr. C. G. Barrett exhibited, for Mr. Sabine, varieties of the following species: viz. one of *Papilio machaon*, bred by Mr. S. Baily, at Wicken, in 1886; one of *Argynnis lathonia*, taken at Dover in September 1883; one of *A. euphrosyne*, taken at Dover in 1890; and one of *A. selene*, taken at St. Osyth, in 1885, by Mr. W. H. Harwood. He also exhibited a long series of *Demas coryli*, reared by Major Still from larvæ fed exclusively on beech, which he said appeared to be the usual food of the species in Devonshire, instead of hazel or oak. Mr. Barrett also exhibited, for Mr. Sydney Webb, a number of varieties of *Arge galathea*, *Lasiommata megæra*, *Hipparchia tithonus*, and *Cœnonympha pamphilus*, from the neighbourhood of Dover.—The Rev. J. Seymour St. John exhibited a variety of the female of *Hybernia progemmaria*, taken at Clapton in March last, in which the partially developed wings were equally divided in point of colour, the base being extremely dark and the outer portion of the wing very pale.—The Rev. Canon Fowler made some remarks on the subject of protective resemblance. His attention had been recently called to the fact that certain species of *Kallima* apparently lose their protective habit in some localities, and sit with their wings open; and Dr. A. R. Wallace had informed him that he had heard of a species sitting upside down on stalks, and thus, in another way, abandoning its protective habits. Mr. W. L. Distant referred to certain species of South African butterflies, which, when at rest, were protected by their resemblance to the plants on which they reposed, or by their resemblance to the rocks on which they settled, but which frequently abandoned their protective habit and sat with open wings. Mr. Barrett Mr. McLaclan, Mr. Jacoby, Mr. Champion, Mr. H. Goss Canon Fowler, and Mr. Frohawk continued the discussion.—Mr. Goss informed the meeting that, in pursuance of a resolution of the Council passed in March last, he and Mr. Elwes had represented the Society at the recent Government inquiry as to the safety and suitability of the proposed rifle range in the New Forest, held at Lyndhurst by the Hon. T. W. H. Pelham, on the 20th, 21st, 22nd, and 23rd inst., and that they had given evidence at such inquiry.

PARIS.

Academy of Sciences, April 25.—M. d'Abbadie in the chair.—On the photography of colours (second note), by M. G. Lippmann. In his first communication on colour photography, M. Lippmann remarked that the results would have been much better if isochromatic films had been employed. He has now obtained some new pictures, and presented them to the Academy. Silver bromide films, stained with azalin and cyanin, were used in connection with the arrangement previously explained. The solar spectrum appears to have been photographed in all its beauty with an exposure of about thirty seconds. On two of the plates the colours viewed by transmitted light are seen to be complementary to those given by reflected light. A photograph of a window containing red, green, blue, and yellow glasses appears to be very satisfactory. Others of a group of drapery and a parrot were obtained with an exposure of from five to ten minutes. Several hours' exposure were given to a plate of oranges surmounted by a poppy, diffused light being employed. In all cases the forms of the objects were reproduced as well as the colours.—On the means employed in producing rain artificially, by M. Faye. The author states Espy's opinions on the formation of cyclones and other atmospheric disturbances, and quotes a letter on rain-making experiments carried out in Florida in 1857. He is of opinion that the theory which led to the experiments is wrong. For, according to M. Faye, (1) water-spouts, tornadoes, and cyclones move quickly during calm weather: ascending columns of heated air do not move. (2) Tornadoes and water-spouts whirl vigorously in a certain direction: ascending columns of air do not rotate, or only do so very faintly. (3) Tornadoes and water-spouts are cold in the centre: ascending columns of air are warm. (4) Tornadoes and water-spouts descend from clouds: ascending columns rise towards the clouds, &c.—On the division, according to terrestrial latitudes and longtitudes, of the geological groups on the earth, by M. Alexis de Tillo. The following are the sums of the distribution of groups of rocks, &c., given in the tables for every ten degrees of latitude; the dimensions are expressed in millions of square kilometres:—

Pre-Cambrian ...	19·85	Glaciers ...	1·94
Primary ...	17·18	Igneous rocks ...	3·96
Secondary ...	19·85	Coral islands ...	0·02
Tertiary ...	8·71	Region { Explored	98·03
Quaternary ...	19·17	Region { Unexplored	36·16
Gravels ...	7·35	Total ...	134·19

Tables are also given showing the proportion of the known surface of the globe occupied by each of the above groups, and also showing the distribution in longitude.—Observations of two new planets, discovered at Nice Observatory on March 22 and April 1, by M. Charlois. Observations for position are given.—Photography of the Ring Nebula in Lyra, by M. F. Denza.—Solar observations made during the first quarter of 1892, by M. Tacchini. (See Our Astronomical Column).—On a problem in mathematical analysis connected with equations in dynamics, by M. R. Liouville.—Direct and indirect measures of the angle which the surface of a liquid makes with glass which it does not wet, by M. C. Maltézos.—On thermo-electric phenomena produced by the contact of two electrolytes, by M. Henri Bagard.—Addition to the law of the position of nervous centres, by M. Alexis Julien.—Analysis of a chromiferous clay from Brazil, by M. A. Terreil.—On the waters and muds of the lakes of Aiguebelette, Paladru, Nantua, and Sylans, by MM. L. Duparc and A. Delebecque.

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THURSDAY, MAY 12, 1892.

BRACHIOPODS OF THE ALPINE TRIAS.

Brachiopoden der Alpinen Trias. Von A. Bittner. *Abhandl. d. k. k. geologischen Reichsanstalt*, Bd. xiv. 4to, 325 pages, 41 plates, and numerous zincotypes in the text. (Vienna: A. Hölder, 1890.)

BOOKS on Triassic fossils, helping as they do to bridge over the gap in our knowledge of those life-forms that led from the ancient times to the middle ages of earth-history, will always be welcomed by both geologist and biologist, especially when, as in the fine work before us, they show signs of wide learning and elaborate research, and are accompanied by such figures and diagrams as place their stores of information within easy reach of all.

The Triassic rocks and Brachiopods best known to English collectors, and indeed to geologists in general, through the writings of Münster, v. Klipstein, and Laube on the one hand, and Suess and Zugmayer on the other, are those of the St. Cassian argillaceous beds and of the Hallstatt limestone. Besides these, the Brachiopods of the Alpine Muschelkalk have been largely worked out by Schauroth and Boeckh. In addition to those from these well-known horizons, Mr. Bittner surveys the Brachiopod faunas from a large number of other beds, including the Rhætic, few of which beds have been systematically worked before, but all of which may be compared with those of the above-mentioned better-known types.

Mr. Bittner has divided his work into two parts: the first, of 287 pages, being devoted to the description of species and the comparison of faunas; the second dealing with the morphology and distribution of the several genera. It will be convenient to follow a similar order in this article.

Part I. follows primarily a stratigraphical, and secondarily a topographical arrangement, so that the species are described under various faunas. In one place, however, the author stops to give us two interesting essays, one on his new genus *Halorella*, the other on the Triassic species of *Rhynchonella*, both of which should by rights have come in the second part of his work.

The descriptions are based chiefly on materials in the Museum of the Geologische Reichsanstalt and the Hofmuseum in Vienna, although a very large number of other collections—private and public—have been consulted by the author. Among these, however, we fail to notice the British Museum, which contains many of v. Klipstein's types. Mr. Bittner, it should be mentioned, invites collectors and others to send him all their material, and promises to determine the species carefully and to describe any new ones. The present volume is sufficient guarantee that the work will be carefully done.

It may well be imagined that the task set before our author was no light one. There appear to be 398 species of Brachiopods in the Trias of the Alps, and of these 216 are named for the first time in this work. But we wish that Mr. Bittner had made his book a little more of what one expects it to be from its size and scope—namely, a monograph of the Brachiopods of the Alpine Trias. Such a monograph would have included a diagnosis, if not a figure, of every species of Brachiopod known to occur in these beds; it would have summarized the literature of the subject, and it would have shown at a glance under each species in what beds and at what localities it occurred. Such a work, which need not have been a page longer than the present, would have been worth a library to students of these fossils. The author, however, has elected merely to crowd our shelves with one more book, and not even a book in the highest sense of the word. He has unfortunately not thought it necessary to give even descriptions of previously named species, unless he has something new to say about them, while his whole volume is innocent of any serious attempt at a diagnosis. Here is an example—no unfavourable one—of his method:—

> "*Rhynchonella Attilina*, nov. sp."
>
> "A small *Rhynchonella* occurring in numbers, which at first sight reminds one of the above-described *Rh. trinodosi m.* The simplest examples are very near that species and easily confused with it."

He then goes on to contrast *R. Attilina* with *R. trinodosi*, point by point, for twenty-seven lines, and so ends without any independent description of his new species, and with nothing to say how it differs from the ninety other Triassic species of the genus, not to mention the rest. And there are many worse instances than this.

We are aware that Mr. Bittner is by no means the only offender in this respect; were he so, our complaints would be unnecessary. He is merely an example of a body of writers, far too numerous in our own country, who seem to have the notion that this sort of thing is science. It is what science has to put up with, and if possible to make science out of; but there is generally about as much science in it as in an auctioneer's catalogue. The writers in question seem never to have heard of Linnæus. Had they studied his writings, they would understand that, for systematic purposes, the diagnosis is everything, that every new species described often necessitates a re-diagnosing of all other species in the genus, and in many cases involves a fresh diagnosis of the genus itself. Were this appreciated, fewer synonyms would disgrace our lists.

To return to Mr. Bittner, whose work is after all more scientific than that of most of these name-mongers. It is noticeable that he, as a rule, gives no measurements, leaving it to readers to gather these from the plates. The task of calculating average measurements is of course irksome; still it is often possible to compare species more accurately by their means than by any other.

Neither does our author ever take the trouble to inform us of the meanings of his trivial, or even generic names. "Why *R. trinodosi?*" we ask, and infer—though from nothing under the head of the species itself—that it is due to the association of the species with *Ceratites trinodosus.* But there are many names that still remain to the present writer unsolved enigmas: such are *S. pia*, *S. avarica* (unless this means *avaricensis*), and *R. generosa.* It is also rather difficult to understand why three species of Rhynchonella, all from the same district, should be called *R. cimbrica*, *R. teutonica*, and *R. venetiana.* We venture to think, however, that the climax of nomenclatural aberration is reached in such a name as "*Ko-*

ninckina Leopoldi Austriæ nov. spec." Here the author is following the bad example of "*Spiriferina Maximiliani Leuchtenbergensis* Klipstein *sp.*," and similar preciosities of the older writer. If emperors and dukes need such distinctive appellations, what must be done for ordinary mortals? Some day we shall see "*Robinsonia Gulielmi-Smithi-South-Kensingtonensis* Jones *sp.*" Seriously, no amount of snobbishness can make these names binomial. Mr. Bittner will need no apology for these remarks, for he has written:—

> "Es wäre nur zu wünschen, dass man sich auch gegen andere . . . Uebelstände und Missbräuche in der Nomenclatur . . . in so eifriger Weise aussprechen . . . möchte."

In his investigations into the internal structure of some of these Brachiopods the author has received much help from the researches of Mr. H. Zugmayer, many of which are here published for the first time. Like the Rev. Norman Glass, Mr. Zugmayer has devoted much attention to the shape of the lophophoral support. While Mr. Glass, however, works his specimens out by careful dissection, Mr. Zugmayer adopts the fashionable method of cutting a series of sections. Morphologists, as we know, look down on palæontologists, and their real reason is that the latter cannot use the Caldwell microtome; but the figures here published will go far to remove that reproach. One could wish, however, for more diagrams elucidating the results obtained by the sections.

The author has made a large number of new subgenera and a few new genera, the details of which are too technical for reproduction here. The following forms may be noted as strictly characteristic of the Trias:—The Koninckinidæ, especially *Koninckina* and *Amphiclina*; the Thecospiridæ; certain Rhynchonellidæ, viz. *Halorella*, *Dimerella*, and the subgenera *Austriella* and *Norella*; *Camerothyris* and *Cruratula*, which are two subgenera of *Waldheimia*; *Nucleatula* and *Juvavella*, two new genera of the Centronelline type of Terebratulidæ; long-beaked forms of *Retzia*; most of the diplospire *Spirigeræ*; the septate *Spirigeræ* (*Amphitomella*); *Mentzelia*, a subgenus of *Spiriferina*; the doubtful *Badiotella*; and some peculiar *Cyrtinæ*.

Turning now to Part II. of the work, we may note the following details concerning some of the above forms.

The numerous groups of *Spiriferina*, though convenient, are of uncertain value; for it is uncertain whether, in determining affinities, more weight should be attached to the structure of the beak or to the ribbing. Ribbing varies greatly in forms with the same beak-structure, *e.g.* the *Hirsuta* group. This is an instructive instance of the difficulty of classifying on other grounds than those of phylogenesis.

The *Cyrtinæ* are interesting. *C. Fritschii* is a new species in which the pseudo-deltidium, which in other Brachiopods is a single plate closing in the peduncular aperture, consists of two rows of separate scale-like plates alternating with one another. *C. Buchii* and *C. Zittelii* appear to have been attached, at least in youth, by the apex of the larger valve, which is often curiously distorted. This fact may explain the pseudo-deltidium of *C. Fritschii*, for it may have been flexible to allow of the passage of a short peduncle or byssus. These forms lead up to *Cyrtotheca*, which was attached by one of the broad surfaces supporting the beak of the larger valve. The unique original of this genus has unfortunately been lost.

The genus *Spirigera* is divided into numerous groups, many of which have a secondary lamella running alongside of the main lamella that supports the spires of the lophophore; they are therefore said to be "diplospire." This structure is extremely rare in Palæozoic species of the genus.

The Koninckinidæ form the most widely distributed family of the Upper Alpine Trias; and of it, as well as of the four genera belonging to it, a complete description is given. In Mr. Bittner's opinion this family has been shown by the researches of Mr. Zugmayer to be closely allied to the Spiriferidæ. The lophophore support is diplospire. *Amphiclinodonta*, a new genus of this family, has an extremely complicated hinge and teeth.

Badiotella is a remarkable genus founded on a single unsymmetrical large valve. Its resemblance to *Streptorhynchus* suggests that it is probably a relic of the Strophomenidæ.

Juvavella and *Nucleatula* are two new genera of the Centronellinæ found in the Hallstatt limestone. This group has not hitherto been found in rocks of so late an age.

The general relations of the Triassic Brachiopods of the Alps may be summarized as follows:—

In the Lower Trias there are only two species, a *Lingula* and a *Discina*.

In the Muschelkalk there are forty-two species, referable to *Lingula*, *Discina*, *Terebratula*, *Waldheimia*, *Rhynchonella*, *Spirigera*, *Retzia*, *Spiriferina*, and *Mentzelia*. All these, in closely allied or even identical forms, appear again in the Upper Trias.

The Upper Trias contains over 300 species, including all the types already mentioned. This, therefore, is a truer representation of the Brachiopod fauna of the Triassic period. The faunas of the Lower and Middle Trias are less, merely because the conditions were no so favourable in the Alpine area.

In the Triassic fauna hingeless genera are very rare.

Among the hinged genera two families, each containing over 100 species, are noticeable: the Spiriferidæ for the large number of genera, subgenera, and minor groups, combined with a paucity of individuals; the Rhynchonellidæ for the large number of individuals, with few well-marked genera or subgenera. The philosophic naturalist is tempted to suggest that the few divisions recognized in the latter family may be due to the very richness of the material.

The spire-bearers almost exactly equal the non-spire-bearers in the number of species. The latter, however, exceed in individuals, and, from this period onwards, increase in importance, while the spire-bearers soon disappear from the rock record. It is, therefore, very noteworthy that, just before their extinction, the spire-bearers should not only develop new branches—the Koninckinidæ and (?) Thecospiridæ—but should also break up into so many genera, subgenera, and minor groups. A similar efflorescence, as Mr. Bittner observes, marked the later history of the Terebratulidæ, a family now almost extinct.

These facts are certainly opposed to the statement of Hyatt that stems give off numerous forms in their early youth, when the field is free, but not in old age, when they begin to be crowded out by the struggle for existence. Possibly, however, the opposition is more apparent than real, and will disappear when the Brachiopoda shall have been studied under the guidance of modern principles of evolution. Such a study has begun in America, but we regret to see little sign of it in the present work. No doubt Mr. Bittner is only waiting to complete his knowledge, before entering on a field where he will meet with worse obstacles than hard rocks and battered specimens—with illusion and ignorance, prejudice and envy, obstinacy and superstition. When he does start, we shall be the first to wish him good speed.

F. A. BATHER.

A TEXT-BOOK OF POLITICAL ECONOMY.

Elements of Economics of Industry. Being the first volume of "Elements of Economics." By Prof. Alfred Marshall. (London: Macmillan and Co., 1892.)

THE nomenclature of this work reminds us of the ancient custom according to which the alternate generations of a family were named alike. As the son of Hipponicus was called, not after Hipponicus, but after Hipponicus' father, Callias; so the "Economics of Industry," though sprung from the "Principles of Economics," of which it is a miniature, yet does not derive its title from that work, but from the predecessor of that work, the well-known text-book which saw the light some thirteen years ago. The first and the second "Economics of Industry" are unlike in form; but a general family resemblance may be traced between the two generations. A sort of reversion is presented by the circumstance that trades unions are discussed in the latest as in the earliest of our author's books; but not in the intermediate "Principles of Economics." The character of the "Economics of Industry" the younger, and its position in the family group, may best be indicated if, comparing it with its immediate predecessor, the second edition of the "Principles of Economics," we notice what has been retained what has been omitted, and what has been added.

The fundamental principles of political economy as enounced by Prof. Marshall in his *magnum opus*, have been transferred to the pages before us without alteration. The conception of economics as the science of measurable—not necessarily selfish—motives is again the starting-point. Thence we are led to the construction of demand-curves, and that construction by which the benefit which the consumer derives from fall in price is represented. Corresponding to demand-curves and "consumer's rent" are, on the other side of the counter, so to speak, supply-curves and rent proper. But the correspondence is not close, and the diagrammatic representation of the conditions of supply presents peculiar difficulties. It is perplexed by the principles of "increasing" and "decreasing returns." Difficulty is caused by the distinction—first clearly indicated by Prof. Marshall—between "long periods" and "short periods." An effort is required to realize the idea of supply, as it were, projected through time—the vast conception of skilled work put upon a future labour-market by parental providence for vicarious remuneration. The forces of demand and supply determine price, acting simultaneously, in the sense in which equations are called simultaneous. "Just in the same way, when several balls are lying in a bowl, they mutually determine one another's position." The law of demand and supply—the gravitation of the economic system—governs widely distant spheres; not only exchange in the proper narrow sense, but also distribution. Prof. Marshall was, we believe, the first clearly to discern this identity. But, while contemplating the unity of the genus, he has not lost sight of the diversity of the species. No one else has so fully enumerated and allowed for what may be called the *propria* of the different markets; such as the circumstance that many of the disadvantages in bargaining to which the workman is subject are *cumulative.* It is this union of wide general views with minute knowledge of concrete details which imparts peculiar weight to Prof. Marshall's recommendations respecting questions of practical moment, such as the limitation of the hours of labour.

These lessons have now been made easier by the omission of much that is accessory and abstruse in the original volume; in particular, the literary criticisms and the mathematical demonstrations. Among the latter class of omissions two seem conspicuous: the difficult formula for discounting future pleasure, and what may be called the higher theory of the supply-curve, including its possible plural intersection with the demand-curve. Difficult, the present writer may well call these theories, for he has to confess that he was mistaken in some strictures passed upon them in a review of the first edition of the "Principles of Economics" (NATURE, August 14, 1890). The fuller statements about those subjects contained in the second edition made it evident that there had occurred what more frequently occurs than is acknowledged: the author was right, and the critic was wrong. The little incident may be referred to as justifying the plan of abridgment which has been adopted—by omission rather than compression of difficult demonstrations. "It seemed that the difficulty of an argument would be increased rather than diminished by curtailing it and leaving out some of its steps." There results a text-book eminently fitted for the purpose of education, embodying the result of original reflections in a shape adapted to the needs of beginners; complete in itself, yet capable of being supplemented by the judicious teacher who, referring to the "Principles of Economics," may point to that higher world of thought and lead the way.

Practical exigencies have induced Prof. Marshall to forestall the discussion of trade unionism which may be expected in the second volume of the "Principles of Economics." In the work before us he thus states the claim of unions to make economic friction act in favour of the workman:—

> "A viscous fluid in a vessel tends to form a level surface; but, if from time to time an artificial force pushes down the left side, which we may take to correspond to wages, it may reasonably be maintained that the average position of the left side is lower than it would have been without such interference, in spite of the in-

disputable fact that the force of gravitation is constantly tending to reinstate the position of equilibrium. What unions claim to be able to do corresponds to applying frequent and stronger pressure on the right-hand side, thus causing profits to yield the higher level to wages."

To this argument there is opposed a preliminary objection, that friction is not strong in the labour-market, that competition is much more effective than unionists assume. There is wanting, indeed, an exact measure of this friction, as in the case of so many economic forces; one must be content with a rough mean between the divergent statements of experienced persons. The claim on behalf of the unions may now be considered under two heads—with reference to a single trade, and where the union is supposed to be extended to all the trades of a country. But we cannot here follow the subtle argument into all the intricacies of the subject. We shall refer only, or chiefly, to the latter case—which, in view of the developments of the new unionism, cannot be regarded as imaginary—the case of a supposed universal union. The main argument against this sort of unionism is that a rise of wages obtained at the expense of profits tends to cause a diminution, or at least a check to the growth, of those accumulations from which the remuneration of the labourer is derived. "This old argument has both gained and lost strength in recent times." Upon a balance of considerations, it still appears weighty; it is even cumulative, the diminution of the national dividend being progressive from year to year. Two counter-arguments are urged by unionists. First, they claim that through their policy the machinery of the labour-market works more smoothly; thus it saves the employer trouble and anxiety to be able to buy his labour—just as it does to buy his raw material—at wholesale prices (a fixed minimum rate of wage). After a detailed consideration of the policy of trade unions, Prof. Marshall concludes that in some cases—especially where the invigorating effect of foreign competition is felt—"trade unions, on the whole, facilitate business." It is sometimes otherwise with trades which have a monopoly of some special skill. A second great argument in favour of trades unions is that they have increased the efficiency of workmen, thereby increasing the total produce. The beneficial effect on the standard of life is to be admitted in cases like that of the London Docks. "But this answer is not open to those unions or branches of unions that in effect foster dull and unenergetic habits of work." Where reasons are so conflicting, it were to be wished that direct observation were available. But here, as elsewhere in economics, history is difficult to interpret. There is, indeed, the patent fact that those occupations in which wages have risen most in England are those in which there are no unions—namely, the kinds of domestic service and the employments of women for which there has been an increase of demand and a check of supply. On the other hand are urged cases in which higher wages have attended stronger unions. But we cannot be quite certain that the gain of one trade is not obtained at the expense of a greater loss to some other trade. Also prosperity may be rather a cause than a consequence of the prevalence of trades unions. The general conclusion appears to be that unions are not to be condemned or extolled in the abstract, but only after attending to the particular character of each, and considering whether its policy complies with the conditions of success. Where the consequences for good or evil are so widespread, and the issues are to a large extent moral—whether unionists are procuring a small good immediately and for themselves at the expense of a greater loss in the future or to other classes—it is natural to appeal to public sympathy and criticism. "Public opinion, based on sound economics and just morality, will, it may be hoped, become ever more and more the arbiter of the conditions of industry." Among the means of educating public opinion we should place high the study of the "Economics of Industry."

F. Y. E.

OUR BOOK SHELF.

Elements of Materia Medica and Therapeutics; including the whole of the Remedies of the British Pharmacopœia of 1885 *and its Appendix of* 1890. By C. E. Armand Semple, B.A., M.B. (Cantab.), M.R.C.P. Pp. 480. (London: Longmans, Green, and Co., 1892.)

WHEN a knowledge of medical botany was absolutely necessary to the student of materia medica, such works as Pereira's "Elements" and Bentley's "Text-book of Organic Materia Medica" supplied a real want in this direction. But with the altered ideas of modern teaching there is a growing tendency among examiners to demand rather a thorough knowledge of the chemistry and intimate action of the active principles of drugs than of their botanical sources. This being the case, it is a little difficult to understand why the work at present under notice has been written. Mr. Semple thinks that by the aid of his book and of the illustrations contained therein, the student will be able to master the subject, and will have the facts impressed upon him more vividly by the pictures. We think, however, that most will agree with us that one of the already well-known text-books, such as the excellent one by Mitchell Bruce, or the larger and more comprehensive one by Brunton—used in connection with a materia medica museum—will make the subject at least equally interesting, and enable the worker to pass a far better examination. Since the 440 illustrations included in the text appear to be brought forward as the strong point of Mr. Semple's cram-book, we must draw attention to a few of their peculiarities noticeable at a glance. In the first place, non-officinal parts of plants are sometimes illustrated, and not the officinal parts. Again, some of the plates, though good enough in themselves, such as those illustrating the extraction of tar and the collection of asafœtida, narrowly escape being ludicrous in a work on materia medica. Others, such as that showing a sulphuric acid factory, give the student no idea of the principles involved in the processes of preparation, and it is these alone which are of importance to him. Many sketches are evidently inserted simply because the blocks were at hand. Lastly, in the inorganic portion we regret to notice the complete absence of chemical equations and formulæ, without a knowledge of which the student's knowledge is indeed rudimentary.

Elementary Lessons in Heat. By S. E. Tillman, Professor of Chemistry, U.S. Military Academy. Second Edition. (New York: John Wiley and Sons. London: Gay and Bird. 1892.)

THE "Lessons" presented in this volume were originally prepared for the use of students at the U.S. Military Academy. They are well fitted for students who can devote only a limited time to this branch of science, for the author not only knows his subject thoroughly, but understands how to deal with it in a way that shall be readily intelligible. His main object has been to direct attention only to important facts and principles, and to bring out the various links by which they are logically connected with one another. There are eleven chapters, in which he treats of thermometry, dilation of bodies, calorimetry, production and condensation of vapour, change of state, hygrometry, conduction, radiation, thermo-dynamics, terrestrial temperatures, aërial meteors, and aqueous meteors. Few changes have been made in the present edition, but the author has introduced a collection of elementary problems, which, as he says, may be "advantageously solved in connection with the subject-matter to which they appertain."

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Aurora.

THERE was a fine aurora visible in this locality on Saturday night, April 23. It was seen at intervals, whenever the clouds broke away, until after midnight. This display is specially interesting, because it forms the continuation of a series of recurrences, at the precise interval of twenty-seven days, which began in December, the dates being as follows: December 9, January 5, February 2, February 29, March 27, and April 23. Some of these displays have been brilliant, and all of them have been well defined. In the table of auroras which I have constructed, based upon a periodicity corresponding to the time of a synodic revolution of the sun—namely, twenty-seven days, six hours, and forty minutes—there was, for several years preceding the sun spot minimum in 1889 and 1890, a return each spring of series of recurrences associated with the same part of the sun as that above described. A corresponding systematic tabulation of the records of solar conditions shows that this association bears a direct relation to reappearances at the eastern limb of an area which has been much frequented by spots and faculæ, and which has been located persistently south of the sun's equator. In like manner there are other areas located in the sun's northern hemisphere which have been much disturbed, and whose reappearances at the eastern limb have been attended year after year by series of recurrences of the aurora, in the autumn months chiefly, if not exclusively. From this it would appear that, in order that a solar disturbance may have its full magnetic effect upon the earth, it is necessary that it should be at the sun's eastern limb, and as nearly as possible in the plane of the earth's orbit. It appears, also, that the disturbances which recur upon certain parts of the sun so persistently year after year have greater magnetic effect than those of comparatively sporadic character located elsewhere.

Lyons, N.Y., April 25. M. A. VEEDER.

The White Rhinoceros.

IN my "Naturalist in the Transvaal" (p. 5), I recently deplored the supposed fact that a perfect skin or skeleton of *Rhinoceros simus* was unknown in any Museum; and I relied for my information on the interesting communication in your columns made by Dr. Sclater (vol. xlii. p. 520).

I have just received a very welcome letter from Dr. Jentink, the Director of the Leyden Museum, stating that there are two skins to be found in that collection, "one in a rather bad state, but the other a beautiful stuffed specimen, measuring more than 3½ metres."

Dr. Jentink had published this information in *Notes from the Leyden Museum* (October 1890), a communication I had not seen when I returned from the Transvaal and wrote on the matter.

This is a most gratifying fact for all zoologists, and the Leyden Museum appears to have a unique treasure.

Purley, Surrey, May 3. W. L. DISTANT.

The Line Spectra of the Elements.

IN Prof. Runge's article on the spectra of the elements in last week's issue of NATURE (p. 607) he refers to my explanation of double lines in the spectra of gases ("Cause of Double Lines in Spectra," Trans. of the Roy. Dublin Soc., vol. iv. 1891, p. 563); and says:—"I do not understand the decomposition of the arbitrary curve" [rather, of the actual motion of the electric charge within the molecules of the gas] "in a series of superposed ellipses" [rather, into a series of pendulous motions in ellipses]. "For the movement is supposed not to be periodical" [rather, is not known to be periodical], "and Fourier's theorem then would not apply, at least the periods of the superposed ellipses would not be definite, as long as there are no data except the arbitrary curve itself" [rather, no data except those furnished by the positions and intensities of the spectral lines].

Prof. Runge will pardon me if I say that this objection seems to me to be of the same kind as a doubt with respect to the value of tables of logarithms on the ground that many logarithms are incommensurable with integer numbers, and therefore cannot equal decimal fractions.

Take, for example, a simple vibratory movement of an electron within the molecules, represented by

$$x = a\sin\left(2\pi\frac{mt}{j}\right) + b\sin\left(2\pi\frac{\pi mt}{j}\right), \quad \ldots \ldots (1)$$

which would give rise to two lines in the spectrum with oscillation-frequencies m and πm in each jot of time. This, Prof. Runge objects, cannot be analyzed by Fourier's theorem, because it is not periodic. But

$$x = a\sin\left(2\pi\frac{mt}{j}\right) + b\sin\left(2\pi\frac{3{\cdot}14159\,mt}{j}\right), \quad \ldots (2)$$

$$x = a\sin\left(2\pi\frac{mt}{j}\right) + b\sin\left(2\pi\frac{3{\cdot}141593\,mt}{j}\right), \quad \ldots (3)$$

$$x = a\sin\left(2\pi\frac{mt}{j}\right) + b\sin\left(2\pi\frac{3{\cdot}1415927\,mt}{j}\right), \quad . \quad (4)$$

&c., &c., &c.,

being periodic, can be so analyzed. The motion represented by the first of these (Equation 2) approximates for a certain time to the actual motion which is represented by Equation 1. The motion represented by the next (Equation 3) approximates more closely and for a longer time; and so on. So that Fourier's theorem can be applied to motions which approximate to the non-periodic motion represented by Equation 1, in any assigned degree and for any assigned time; just as a decimal can approximate in any assigned degree to the value of log 8, although no decimal can equal that logarithm.

G. JOHNSTONE STONEY.

9 Palmerston Park, Dublin, May 1.

On a Proposition in the Kinetic Theory of Gases.

IN last month's *Philosophical Magazine* there is a paper by Lord Rayleigh criticizing a demonstration by Maxwell of the equality of the products $dp_1 \ldots dp_n, dq_1 \ldots dq_n$, and $dP_1 \ldots dP_n, dQ_1 \ldots dQ_n$, where the p's and P's are the momenta, and the q's and Q's the co-ordinates, of a system at the beginning and end of any interval of time.

Lord Rayleigh correctly points out that the assumption of E, the total Energy, as an independent variable, vitiates the proof, and he suggests the substitution of Hamilton's principal function S for the characteristic function A, with t, the time, as an independent variable.

Prof. Boltzmann took a similar objection to Maxwell's demonstration in a paper to the *Philosophical Magazine* in the year 1882, in the course of some comments on my use of the proof in a small treatise on the kinetic theory of gases, and I then privately suggested to him the substitution of S for A, with t independent, as proposed by Lord Rayleigh. But unfortunately, as I now see, the proposition $dp_1 \ldots dq_n = dP_1 \ldots dQ_n$, with t independent, although doubtless true, has no application to the particular problem in the kinetic theory of gases to which I was applying it.

My object was to abbreviate and simplify the proof of a fundamental theorem in the subject originally given by Boltzmann, and which may be fairly well illustrated by the following simple case:—

Suppose that in the plane of a projectile there are two infinite parallel straight lines, A and B, and we introduce such a relation between x_0, y_0, x, and y as will express that when the former is a point on the line A the latter will be a point on B, each of the four quantities x, y, u, v may then be expressed as a function of x_0, y_0, u_0, v_0, and it may be proved that

$$dx\, dy\, du\, dv = \frac{V_0}{V} dx_0\, dy_0\, du_0\, dv_0\,;$$

where V_0 and V are the resolved parts of the projectile's velocity perpendicular to the two lines as it crosses A and B respectively.

For instance, let the lines be vertical $x = a$ and $x = b$, where $b - a = c$. Our equations are—

$$\begin{aligned} x - x_0 = c &= u_0 t \\ y - y_0 &= v_0 t - \frac{gt^2}{2} \\ v &= v_0 - gt \\ u &= u_0 \end{aligned}$$

$$\therefore t = \frac{c}{u_0},\quad v = v_0 - \frac{gc}{u_0},\ u = u_0,\ x = x_0 + c,\ y = y_0 + \frac{v_0 c}{u_0} - \frac{gc^2}{2u_0^2},$$

and

$$\Delta = 1 = \frac{u}{u_0}.$$

Also here $t = \frac{c}{u_0}$ is *not* constant, as it depends upon u_0.

Next let the lines be horizontal, $y = a$, $y = b$, $b - a = c$. We then have

$$\begin{aligned} &(1)\ y - y_0 = c = v_0 t - \frac{gt^2}{2} \\ &(2)\ x - x_0 = u_0 t \\ &(3)\qquad u = u_0 \\ &(4)\qquad v = v_0 - gt. \end{aligned}$$

From (1)

$$t = \frac{v_0 - \sqrt{v_0^2 - 2cg}}{g},\qquad x = x_0 + \frac{u_0}{g}\left(v_0 - \sqrt{v_0^2 - 2cg}\right),$$

$$y = y_0 + c,\qquad u = u_0,\qquad v = \sqrt{v_0^2 - 2cg},$$

and our determinant Δ is

$$\begin{vmatrix} 1, & 0, & \dfrac{v_0 - \sqrt{v_0^2 - 2cg}}{g}, & \dfrac{u_0}{g}\left\{1 - \dfrac{v_0}{\sqrt{v_0^2 - 2cg}}\right\} \\ 0, & 1, & 0, & 0 \\ 0, & 0, & 1, & 0 \\ 0, & 0, & 0, & \dfrac{v_0}{\sqrt{v_0^2 - 2cg}} \end{vmatrix}$$

$$= \frac{v_0}{v}.$$

If our lines were $y = mx$ and $y = mx + c$, our additional condition would be

$$y - y_0 = m(x - x_0) + c\,;$$

and the result mentioned could be arrived at, although with a little additional work.

The actual problem proposed by Boltzmann is the same as this in principle, although of much greater complexity, and it is treated by him with the utmost generality. The important thing here is to show that the S function with t constant is of no application, inasmuch as in both of these very simple illustrations we have t a dependent variable depending upon u_0 or v_0.

I am only pointing out that the S method, with t independent, would not help to establish the particular proposition to which I am referring. It may lead to the determination of a law of permanence of distribution independently of this proposition and by a simpler treatment. The Boltzmann treatment, however, avoids the difficulty which may arise from the fact that *encounters*, whether of finite or infinitely short duration, involve the assumption of discontinuous forces, and, therefore, of a corresponding discontinuity in the form of the S function.

A little consideration shows that the condition E constant cannot lead to any determinate relation between the differential products $dp_1 \ldots dq_n$ and $dP_1 \ldots dQ_n$.

For to take again the simple case of the projectile. Here we get four equations between the nine quantities, $x_0\ y_0\ u_0\ v_0$, $x\ y\ u\ v$ and t, whence it is clear that the elimination of t does not enable us to arrive at more than three equations between the remaining eight quantities, and therefore that we cannot express x, y, u, v separately as determinate functions of $x_0\, y_0\, u_0\, v_0$. To enable us to do this we need one additional condition, and this may be supplied in an infinite number of ways. It may be one of the conditions above considered leading to the equation $dx\, dy\, du\, dv = \frac{V_0}{V} dx_0\, dy_0\, du_0\, dv_0$, or it may be the condition t constant leading to the equality of these differential products, and so forth; but the condition E constant supplies no additional relation between the eight variables. This conclusion holds equally for n degrees of freedom, following from the two partial differential equations in $q_1 \ldots q_n$, $Q_1 \ldots Q_n$, to which the characteristic function A is subject, so that the condition E constant leads to no determinate relation between the differential products.

This conclusion is not inconsistent with Maxwell's proof. That proof takes the form—

$$dp_1 \ldots dq_n = \frac{\Delta}{\Delta'} dP_1 \ldots dQ_n,$$

where Δ is equal to Δ', but it may be proved that in this case Δ and Δ' are separately zero, and therefore that, as stated above, no relation can be established between the two differential products.

H. W. WATSON.

Berkeswell Rectory, Coventry.

Palæonictis in the American Lower Eocene.

PALÆONTOLOGISTS will welcome Dr. T. L. Wortman's discovery of a nearly complete skull of *Palæonictis* in the Wahsatch Lower Eocene of Wyoming. The only specimens of this form known hitherto are the two fragmentary lower jaws from the Suessonian lignites of France upon which De Blainville founded the genus in 1841. This specimen includes the facial region of the skull and the complete lower jaws in fine preservation. We owe it to the expert skill of Dr. Wortman, for the fossil was found completely dissociated; he carried several sacks of the *débris* surrounding the fragments fifteen miles to the nearest river, and by careful washing recovered all the teeth.

The skull is about the size and form of that of the Puma (*Felis concolor*), without the long muzzle so characteristic of all the early Carnivores or Creodonts. The dental series is remarkably compressed and reduced, especially in the upper jaw, the formula being: I $\frac{3}{3}$, C $\frac{1}{1}$, P $\frac{4}{4}$, M $\frac{2}{2}$. The third upper molar has entirely disappeared, the second is as small as the little tubercular in the modern cats, the first is smaller than the fourth premolar. The latter tooth, in conjunction with the first true lower molar, is in course of transformation into a *sectorial*. This and many other features point to the conclusion that *Palæonictis* is closely related to the Eocene ancestors of the Felidæ—which have hitherto been considered a gap in the fossil series.

The type, which we may call *P. occidentalis*, will soon be fully figured and described. HENRY F. OSBORN.

American Museum of Natural History, April 19.

WATERSTON'S THEORY OF GASES.

ON the 11th of December, 1845, a paper by Mr. J. J. Waterston, entitled "On the Physics of Media that are composed of Free and Perfectly Elastic Molecules in a State of Motion," was communicated by Captain Beaufort, R.N., to the Royal Society.

This paper was not published at the time, but was relegated to the Archives. It now, however, has just been issued as a part of the current volume of Philosophical Transactions.

It is preceded by an introduction by Lord Rayleigh, one of the Secretaries of the Royal Society, and we cannot do better—in order to call attention to this remarkable paper, which anticipates the present theories in many respects, and to explain how it is that it now appears—than print Lord Rayleigh's introduction as it stands, and also the introduction to the memoir itself.

"*Introduction by Lord Rayleigh, Sec.R.S.*

"The publication of this paper after nearly half a century demands a word of explanation; and the opportunity may be taken to point out in what respects the received theory of gases had been anticipated by Waterston, and to offer some suggestions as to the origin of certain errors and deficiencies in his views.

"So far as I am aware, the paper, though always accessible in the Archives of the Royal Society, has remained absolutely unnoticed. Most unfortunately the abstract printed at the time (Roy. Soc. Proc., 1846, vol. v. p. 604; . . .) gave no adequate idea of the scope of the memoir, and still less of the nature of the results arrived at. The deficiency was in some degree supplied by a short account in the Report of the British Association for 1851 (. . .), where is distinctly stated the law, which was afterwards to become so famous, of the equality of the kinetic energies of different molecules at the same temperature.

"My own attention was attracted in the first instance to Waterston's work upon the connection between molecular forces and the latent heat of evaporation, and thence to a paper in the *Philosophical Magazine* for 1858, 'On the Theory of Sound.' He there alludes to the theory of gases under consideration as having been started by Herapath in 1821, and he proceeds:—

"'Mr. Herapath unfortunately assumed heat or temperature to be represented by the simple ratio of the velocity instead of the square of the velocity—being in this apparently led astray by the definition of motion generally received—and thus was baffled in his attempts to reconcile his theory with observation. If we make this change in Mr. Herapath's definition of heat or temperature, viz. that it is proportional to the *vis viva*, or square velocity of the moving particle, not to the momentum, or simple ratio of the velocity, we can without much difficulty deduce, not only the primary laws of elastic fluids, but also the other physical properties of gases enumerated above in the third objection to Newton's hypothesis. In the Archives of the Royal Society for 1845-46, there is a paper "On the Physics of Media that consist of Perfectly Elastic Molecules in a State of Motion," which contains the synthetical reasoning upon which the demonstration of these matters rests. The velocity of sound is therein deduced to be equal to the velocity acquired in falling through three-fourths of a uniform atmosphere. This theory does not take account of the size of the molecules. It assumes that no time is lost at the impact, and that if the impact produce rotatory motion, the *vis viva* thus invested bears a constant ratio to the rectilineal *vis viva*, so as not to require separate consideration. It also does not take account of the probable internal motion of composite molecules; yet the results so closely accord with observation in every part of the subject as to leave no doubt that Mr. Herapath's idea of the physical constitution of gases appproximates closely to the truth. M. Krönig appears to have entered upon the subject in an independent manner, and arrives at the same result; M. Clausius, too, as we learn from his paper "On the Nature of the Motion we call Heat" (*Phil. Mag.*, vol. xiv., 1857, p. 108).'

"Impressed with the above passage and with the general ingenuity and soundness of Waterston's views, I took the first opportunity of consulting the Archives, and saw at once that the memoir justified the large claims made for it, and that it marks an immense advance in the direction of the now generally received theory. The omission to publish it at the time was a misfortune, which probably retarded the development of the subject by ten or fifteen years. It is singular that Waterston appears to have advanced no claim for subsequent publication, whether in the Transactions of the Society, or through some other channel. At any time since 1860 reference would naturally have been made to Maxwell, and it cannot be doubted that he would have at once recommended that everything possible should be done to atone for the original failure of appreciation.

"It is difficult to put oneself in imagination into the position of the reader of 1845, and one can understand that the substance of the memoir should have appeared speculative, and that its mathematical style should have failed to attract. But it is startling to find a referee expressing the opinion that 'the paper is nothing but nonsense, unfit even for reading before the Society.' Another remarks 'that the whole investigation is confessedly founded on a principle entirely hypothetical, from which it is the object to deduce a mathematical representation of the phenomena of elastic media. It exhibits much skill and many remarkable accordances with the general facts, as well as numerical values furnished by observation. . . . The original principle itself involves an assumption which seems to me very difficult to admit, and by no means a satisfactory basis for a mathematical theory, viz. that the elasticity of a medium is to be measured by supposing its molecules in vertical motion, and making a succession of impacts against an elastic gravitating plane.' These remarks are not here quoted with the idea of reflecting upon the judgment of the referee, who was one of the best qualified authorities of the day, and evidently devoted to a most difficult task his careful attention; but rather with the view of throwing light upon the attitude then assumed by men of science in regard to this question, and in order to point a moral. The history of this paper suggests that highly speculative investigations, especially by an unknown author, are best brought before the world through some other channel than a scientific Society, which naturally hesitates to admit into its printed records matter of uncertain value. Perhaps one may go further, and say that a young author who believes himself capable of great things would usually do well to secure the favourable recognition of the scientific world by work whose scope is limited, and whose value is easily judged, before embarking upon higher flights.

"One circumstance which may have told unfavourably upon the reception of Waterston's paper is that he mentions no predecessors. Had he put forward his investigation as a development of the theory of D. Bernoulli, a referee might have hesitated to call it nonsense. It is probable, however, that Waterston was unacquainted with Bernoulli's work, and doubtful whether at that time he knew that Herapath had to some extent foreshadowed similar views.

"At the present time the interest of Waterston's paper can, of course, be little more than historical. What strikes one most is the marvellous courage with which he attacked questions, some of which even now present serious difficulties. To say that he was not always successful is only to deny his claim to rank among the very foremost theorists of all ages. The character of the advance to be dated from this paper will be at once understood when it is realized that Waterston was the first to introduce into the theory the conception that heat and temperature are to be measured by *vis viva*. This enabled him at a stroke to complete Bernoulli's explanation of pressure by showing the accordance of the hypothetical medium with the law of Dalton and Gay-Lussac. In the second section the great feature is the statement (VII.), that 'in mixed media the mean square molecular velocity is inversely proportional to the specific weight of the molecules.' The proof which Waterston gave is doubtless not satisfactory; but the same may be said of that advanced by Maxwell fifteen years later. The law of Avogadro follows at once, as well as that of Graham relative to diffusion. Since the law of equal energies was actually published in 1851, there can be no hesitation, I think, in attaching Waterston's name to it. The attainment of correct results in the third section, dealing with adiabatic expansion, was only prevented by a slip of calculation.

"In a few important respects Waterston stopped short. There is no indication, so far as I can see, that he recognized any other form of motion, or energy, than the translatory motion, though this is sometimes spoken of as vibratory. In this matter the priority in a wider view rests with Clausius. According to Waterston the ratio of specific heats should be (as for mercury vapour) 1·67 in all cases. Again, although he was well aware that the molecular velocity cannot be constant, there is no anticipation of the law of distribution of velocities established by Maxwell.

"A large part of the paper deals with chemistry, and shows that his views upon that subject also were much in advance of those generally held at the time.

"The following extract from a letter by Prof. McLeod will put the reader into possession of the main facts of the case:—

"'It seems a misfortune that the paper was not printed when it was written, for it shadows forth many of the ideas of modern chemistry which have been adopted since 1845, and it might have been the means of hastening their reception by chemists.

"'The author compares the masses of equal volumes of gaseous and volatile elements and compounds, and taking the mass of a unit volume of hydrogen as unity, he regards the masses of the same volume of other volatile bodies as representing their molecular weight, and in the case of the elements he employs their symbols to indicate the molecules.

"'In water he considers that the molecule of hydrogen is combined with half a molecule of oxygen, forming one of steam, and he therefore represents the compound as $HO_{\frac{1}{2}}$. He does not make use of the term "atom" (although he speaks of atomic weight on p. 18, but thinks it divisible), and if he had called the smallest proportion of an element which enters into combination an atom, he would probably have been led to believe that the molecules of some of the simple bodies contain two atoms, and he might have adopted two volumes to represent the molecule, as is done at the present time. The author calls one volume or molecule of chlorine Cl, one volume or molecule of hydrogen H, and one volume or molecule of hydrochloric acid $H_{\frac{1}{2}}Cl_{\frac{1}{2}}$. If he had regarded the molecules as containing two indivisible atoms, these bodies would have been represented, as now, by the formulæ Cl_2, H_2, and HCl respectively, all occupying two volumes. § 15 shows how near he was to this conception. Gerhardt, in the fourth part of his "Traité de Chimie Organique," published in 1856, points out the uniformity introduced into chemical theory by the adoption of this system.

"'For carbon he makes C = 12, as now accepted, although I do not find how he arrives at this number. He seems to have anticipated one of Ramsay's recent discoveries, that nitrous anhydride (hyponitrous acid, $ON_{\frac{2}{3}}$, No. 26 in the table) dissociates on evaporation into nitric oxide (binoxide of nitrogen, No. 23) and nitric peroxide (nitrous acid, No. 25).

"'The values for the symbols for sulphur, phosphorus, and arsenic, taken from the vapour densities (and which are multiples of what are believed to be the true atomic weights), cause some complexity in the formulæ of their compounds.

"'There seem to be errors in the formulæ of alcohol and ether on p. 49, for they do not agree with those in the table. They ought probably to be written

$$2(HC_{\frac{1}{2}}) + O_{\frac{1}{2}}2H_{\frac{1}{2}} \text{ and } 4(HC_{\frac{1}{2}}) + O_{\frac{1}{2}}2H_{\frac{1}{2}}.$$

"'Considering how nearly Waterston approached what is now believed to be the true theory, it is disappointing to read his controversy with Odling in 1863 and 1864 (*Phil. Mag.*, vols. xxvi. and xxvii.), where he seems to oppose the new formulæ then being introduced. He is very dogmatic about the constitution of hydrate of potash: he very properly insists that we can only obtain a knowledge of the molecular weight of bodies that can be volatilized, and of which the vapour densities can be determined, but he does not see the analogy between the hydrate and oxide of potassium with alcohol and ether, probably because he regards these latter bodies as combinations of water with different quantities of olefiant gas. He writes water $HO_{\frac{1}{2}} = 9$, alcohol $CH_2HO_{\frac{1}{2}} = 23$, and ether $C_2H4 . HO_{\frac{1}{2}} = 37$, whilst he considers potassic hydrate $KO_{\frac{1}{2}} . HO_{\frac{1}{2}} = 56$, and oxide of potassium $KO_{\frac{1}{2}} = 47$, the hydrate having a higher molecular weight than the oxide. If we regard these compounds as derived from water by the replacement of hydrogen by ethyl and potassium respectively, the analogy between the two series is complete (ethyl was discovered in 1849, and is mentioned by Waterston).

$$\begin{array}{rlrl} H_2O & = 18 & H_2O & = 18. \\ (C_2H_5)HO & = 46 & KHO & = 56. \\ (C_2H_5)_2O & = 74 & K_2O & = 94. \end{array}$$

"'From a remark in the *Phil. Mag.* (vol. xxvi. p. 520), I imagined that Waterston had arrived at the double atomic weights of many of the metals now adopted, for he gives that of iron as 56 and that of aluminium as 27, calculated from their specific heats, but there is an error in his arithmetic, for 3·3 divided by the specific heat of iron ·1138 gives 28·998, and 3·3 divided by the specific heat of aluminium ·2143 gives 15·399.'

"With the exception of some corrections relating merely to stops and spelling, the paper is here reproduced exactly as it stands in the author's manuscript.—December 1891."

The author's own introduction to his memoir, which occupies eighty pages of the Philosophical Transactions as now printed, runs as follows:—

"Of the physical theories of heat that have claimed attention since the time of Bacon, that which ascribes its cause to the intense vibrations of the elementary parts of bodies has received a considerable accession of probability from the recent experiments of Forbes and Melloni. It is admitted that these have been the means of demonstrating that the mode of its radiation is identical with that of light in the quantities of refraction and polarization. The evidence that has been accumulated in favour of the undulatory theory of light has thus been made to support with a great portion of its weight a like theory of the phenomena of heat; and we are, perhaps, justified in expecting that the complete development of this theory will have a much more important influence on the progress of science, because of its more obvious connection and intimate blending with almost every appearance of Nature. Heat is not only the subject of direct sensation and the vivifier of organic life, but it is manifested as the accompaniment of mechanical force. It is related to it both as cause and effect, and submits itself readily to measurement by means of the mechanical changes that are among the most prominent indications of its change of intensity. The undulatory theory at once leads us to the conclusion that, inasmuch as the temperature of a body is a persistent quality due to the motion of its molecules, its internal constitution must admit of it retaining a vast amount of living force. Indeed, it seems to be almost impossible now to escape from the inference that heat is essentially molecular *vis viva*. In solids, the molecular oscillations may be viewed as being restrained by the intense forces of aggregation. In vapours and gases these seem to be overcome; vibrations can no longer be produced by the inherent *vis insita* of the molecules struggling with attractive and repellent forces; the struggle is over and the molecules are free; but they, nevertheless, continue to maintain a certain temperature; they are capable of heating and being heated; they are endowed with the quality heat, which, being of itself motion, compels us to infer that a molecule in motion without any force to restrain or qualify it, is in every respect to be considered as a free projectile. Allow such free projectiles to be endowed with perfect elasticity, and likewise extend the same property to the elementary parts of all bodies that they strike against, and we immediately introduce the principle of the conservation of *vis viva* to regulate the general effects of their fortuitous encounters. Whether gases do consist of such minute elastic projectiles or not, it seems worth while to inquire into the physical attributes of media so constituted, and to see what analogy they bear to the elegant and symmetrical laws of aëriform bodies.

"Some years ago I made an attempt to do so, proceeding synthetically from this fundamental hypothesis, and have lately obtained demonstration of one or two points where the proof was then deficient. The results have appeared so encouraging, although derived from very humble applications of mathematics, that I have been led to hope a popular account of the train of reasoning may not prove unacceptable to the Royal Society.—September 1, 1845."

REPORT OF THE ROYAL SOCIETY'S COMMITTEE ON COLOUR VISION.

A COMMITTEE, consisting of Lord Rayleigh as Chairman, Lord Kelvin, Mr. Brudenell Carter, Prof. Church, Mr. J. Evans, Dr. Farquharson, M.P., Prof. Michael Foster, Mr. Galton, Dr. Pole, Sir G. Stokes, and Captain Abney, as Secretary, was appointed by the Council of the Royal Society in March 1890, to consider the question of testing for defective colour vision. Their report has just been presented to the Royal Society, and it possesses great practical interest for all classes, considering that on the average one male out of every twenty-five suffers more or less from this form of blindness.

The Committee have taken evidence as to the tests in general use on the railways, and also as to those which have been for some time adopted by the Board of Trade for the mercantile marine service, and have supplemented it by carrying on practical examinations on their own account. Experts have also given evidence as to the different forms of colour-blindness to be found, and the fact that it may be induced by disease as well as be congenital has been brought prominently forward by Dr. Priestley Smith, of Birmingham, and Mr. Nettleship, of St. Thomas's Hospital, and we have it on their authority that this type is not a negligible one. As an outcome of their investigations, the Committee have unanimously agreed to the following recommendations:—

(1) That the Board of Trade, or some other central authority, should schedule certain employments in the mercantile marine and on railways, the filling of which by persons whose vision is defective either for colour or form, or who are ignorant of the names of colours, would involve danger to life and property.

(2) That the proper testing, both for colour and form, of all candidates for such employments should be compulsory.

(3) That the testing should be intrusted to examiners certificated by the central authority.

(4) That the test for colour vision should be that of Holmgren, the sets of wools being approved by the central authority before use, especially as to the correctness of the three test colours, and also of the confusion colours. If the test be satisfactorily passed, it should be followed by the candidate being required to name without hesitation the colours which are employed as signals or lights, and also white light.

(5) That the tests for form should be those of Snellen, and that they should be carried out as laid down in Appendix VI. It would probably, in most cases, suffice if half normal vision in each eye were required.

(6) That a candidate rejected for any of the specified employments should have a right of appeal to an expert approved by the central authority, whose decision should be final.

(7) That a candidate who is rejected for naming colours wrongly, but who has been proved to possess normal colour vision, should be allowed to be re-examined after a proper interval of time.

(8) That a certificate of the candidate's colour vision and form vision according to the appointed tests, and his capacity for naming the signal colours, should be given by the examiner; and that a schedule of persons examined, showing the results, together with the nature of the employments for which examinations were held, should be sent annually to the central authority.

(9) That every third year, or oftener, persons filling the scheduled employments should be examined for form vision.

(10) That the tests in use, and the mode of conducting examinations at the different testing stations, should be inspected periodically by a scientific expert, appointed for that purpose by the central authority.

(11) That the colours used for lights on board ship, and for lamp signals on railways, should, so far as possible, be uniform, and that glasses of the same colour as the green and red sealed pattern glasses of the Royal Navy, should be generally adopted.

(12) That in case of judicial inquiries as to collisions or accidents, witnesses giving evidence as to the nature or position of coloured signals or lights should be themselves tested for colour and form vision.

These recommendations have been framed after duly weighing all the evidence they have collected, and from the results of the experiments they have carried out during the last two years; and the reasons for adopting them are set forth at some length in the report. The Committee have, perhaps wisely, refused to endorse any particular hypothesis of colour vision, though they have described two, those of Young and Hering, in some detail, no doubt considering that everything which might be debatable had better be avoided when practical recommendations alone were in question. It is, however, a matter of some regret that this should be the case, as a Committee so strongly constituted should have been able, if not to convince every one, at least to lead opinion into proper channels. What little they have said in the notes to the report leads one to suspect that they are not satisfied that either Young or Hering has given a theory which will satisfy all requirements. Leaving, however, the question of theory, we may point out that the practical necessity of insisting, on the grounds of public safety, that certain posts on railways and on board ship should only be filled by persons possessing normal colour vision, no sane man would call in question. The peril that must arise, for instance, if an engine-driver could by any possibility mistake a red signal of danger for a green signal of safety, or if a look-out man on board ship should be liable to make a similar error, is self-evident; and it is to prevent any such risks being run that the Committee buckled to the task of recommending tests which should be efficient and perfectly trustworthy. There has been for a long time a suspicion, if not more than a suspicion, that the examinations carried on for colour vision by the Board of Trade in the mercantile marine were inadequate in both respects; and what little was known regarding the tests employed by the various railway companies engendered the same feeling of distrust, in those who had considered the subject in a scientific spirit. The evidence shows that the Board of Trade examiners have passed on a second or third examination candidates who have been rejected on their first trial. This is a proof of one of two things: (1) either that the tests employed were bad, or else that colour-blindness had been cured or mitigated. There is no evidence to show that congenital colour-blindness is curable; in fact, what there is is in exactly the contrary direction. For although it is true that reds and greens may be correctly named by a colour-blind person, by making him notice certain slight difference in the intensity or purity of the one colour which represents both of these to him, yet no amount of education or coaching would enable him to distinguish between them under the varying atmospheric conditions under which the signals are seen. The Committee had practical trials of various tests made before them at Swindon and elsewhere, with the result that the Board of Trade tests for the mercantile marine allowed several individuals to be passed as possessing normal colour vision whom other tests distinctly proved to be markedly and probably dangerously colour-blind. Under these circumstances it is not surprising that they have condemned such a system of testing, more especially as it is one which necessitates the naming of colours, and recommend those of Holmgren, which have long given practical proof of their ability to discriminate between normal and even slightly defective colour-perception.

The Holmgren test consists in requiring a candidate to select from a large assortment of wools those colours which appear to him to match a skein of pale yellowish green, a pale pink, and a bright crimson. These pale colours are sure to be matched by the colour-blind with colours which are totally different in hue, and the nature of the mistakes made infallibly indicate the character and danger of the blindness.

The evidence shows that some railways have been under the impression that they were using the Holmgren test, but when the colours were examined critically it was found that the hues of the test-skeins of wool were perfectly different from those determined by the distinguished Swedish investigator. If the two trial test-colours of Holmgren were more brilliant and of rather different hues, it is quite possible that persons with defective colour sense might make correct matches, and pass an examination which they really never should do. It is for this reason that the Committee recommend that the standard test-colours should be officially passed by an expert attached to the Board of Trade, as also those colours with which the colour-blind would most probably match them.

There are several of the recommendations which are especially valuable; for instance, that one by which the test should only be intrusted to examiners certified as competent to conduct the examinations. It is obvious that to have an efficient examination, not only should the test be efficient, but also the examiner. We have heard of a railway foreman being armed with a variegated bunch of wools, and insisting on candidates for employment naming them, and rejecting those who failed to give the name which he considered should be given. Such a test by such an examiner is evidently useless and cruel. The right of appeal by the rejected candidates is also wholesome, though it will probably be very rarely exercised; and as the tribunal to whom such an appeal can be carried is an expert, we may be certain that substantial justice will be meted out.

The whole report is valuable, but the labour will be thrown away unless legislative measures are taken to render it effective. It is no use telling railways what they ought to do, but only what they *must* do, in such examinations as are in question. The subject of colour vision is one which is so open to fads that the public require to be safeguarded from faddists who might happen to have ear of Boards of Directors or general managers; for this reason we hope that reasonable legislative action may be taken within a reasonable time.

THE GREAT EARTHQUAKE IN JAPAN, 1891.[1]

WHILE the occurrence of a great earthquake in a district intersected by railways, and traversed by telegraph wires, brings forcibly before the mind—even of the most casual reader of newspaper reports—the awful and destructive results of such a catastrophe, the scientific man cannot fail to note that it is under such conditions as these the best opportunities will be found for obtaining the necessary data upon which to reason concerning these terrible and still little understood movements of the earth's crust. In connection with the Seismological Society of Japan, a system of reporting the times and chief features of earthquake-shocks has been for some years in successful operation, and all station-masters and Post Office agents are required to transmit their records to a central office; the electrical control of the clocks of course giving these reports a value which they would not otherwise possess.

Two considerable earthquakes in recent years have occurred in areas where it was possible to obtain a great mass of accurate time and other observations, and these can scarcely fail to be of great value to the seismologist. The terrible earthquake of Charleston, on August 31, 1886, was felt over a great part of the United States; and at the railway stations, post offices, and other places where the accurate time was kept, many valuable observations were made. The vast mass of material collected has been dealt with by Prof. Simon Newcomb and Captain C. E. Dutton; and from the Report published by the United States Geological Survey, some remarkable and striking conclusions regarding the rate of movement of earthquake waves would appear to have been established. The Gifu or Ai-Gi earthquake of October 1891 has yielded data which the able seismologists of Japan may be trusted to make the fullest use of, when sufficient time has elapsed for the comparison and discussion of the reports.

As a preliminary notice and striking memorial of the catastrophe, the beautiful volume now before us will be gladly welcomed. The book consists of twenty-nine permanent photographic plates, printed on excellent paper, and forty-six pages of letterpress. The energetic authors of the book were on the scene of the earthquake immediately after its occurrence, and all the plates, except three, are reproductions of photographs taken by Prof. Burton for the Imperial University. It is difficult to realize that the collection of the materials for this handsome book, with the execution of its luxurious typography, illustrations, and binding have been all completed within the short space of two months, and it says much for the enterprise and activity of the Japanese publishers, as well as of the authors, that such a result should have been possible.

One of the most striking effects of the Charleston earthquake, as described in Captain Dutton's report, was the twisting laterally of the permanent way on railway lines. On Plate x. of the work before us a similar serpentine twisting of the railway, suggesting a permanent compression in the line of the rails, is shown to have been effected, and the photograph constitutes a beautiful permanent record of the result. Still more striking are the phenomena displayed at some of the railway bridges, especially that of Nagara Gawa, which is very fully illustrated in Plates xxii., xxiii., xxiv., xxv., and xxvi. Our illustration is a reproduction of one of these plates. Not only have the lattice-work sections of the bridge been snapped asunder, but the great tubular piers have been thrust through the floor on which the railway lines are laid, these latter being forced up in great curves. Many of these photographs tell, incidentally, a very sad story of the loss and suffering endured by the people of the district.

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[1] "The Great Earthquake in Japan." By John Milne, F.R.S., Professor of Mining and Geology, and W. K. Burton, C.E., Professor of Sanitary Engineering, Imperial University of Japan. With Plates by K. Ogawa. (Yokohama, Japan: Crawford and Co. London: E. Stanford, 1892.)

In the short descriptive remarks which accompany the plates, Prof. Milne has succeeded in giving us much valuable information concerning the earthquake. The Gifu plain is situated about the centre of the Japanese Empire, and consists of a thick alluvial deposit resting on metamorphic rocks, the district being highly cultivated and thickly populated. The severely shaken district, in which complete destruction of buildings and engineering works occurred, measured 4200 square miles, but the effects were felt over an area of 92,000 square miles; and ten thousand people lost their lives, while fifteen thousand were wounded. The earthquake is believed to have originated in the Mino Mountains; but it was in the soft alluvial plain adjoining that the earth-movements were most severely felt. The district thus violently affected supported a population of about 800 to the square mile. Earthquakes have been recorded as occurring in this area, which lies quite away from any volcanic centres, in 1826, in 1827, in 1859, and in 1880; and during the last ten centuries there have been many terrible catastrophes affecting this area which are noticed in the Japanese records.

We look forward with much interest to the publication of the full account of this destructive, and in many respects remarkable, display of seismic energy, which is promised to us by the Professors of the Imperial University of Japan.

J. W. J.

THE ROYAL SOCIETY SELECTED CANDIDATES.

THE following fifteen candidates were selected on Thursday last (May 5) by the Council of the Royal Society to be recommended for election into the Society. The ballot will take place on June 2, at 4 p.m. We print with the name of each candidate the statement of his qualifications.

Robert Young Armstrong, Lieut.-Colonel R.E.,

From 1870 to 1875 was Assistant Instructor in Submarine Mining and Electricity, and from 1875 to 1882 was Instructor. From 1884 to the present date, Inspector of Submarine Defences of the United Kingdom, Military Ports, and Coaling Stations. From June 1883 to December 1888, adviser to the Board of Trade in electrical matters connected with the Electric Lighting Acts. Was connected with the development of the present apparatus and electrical and mechanical processes employed in submarine mining, and with the compilation of the army instructional books and methods on electricity and submarine mining since 1870. Distinguished as an electrical engineer. It may be said that the present satisfactory state of defensive torpedo warfare in this country is very largely due to his ability and energy.

Frank Evers Beddard, M.A. (Oxon.),

Lecturer on Comparative Anatomy, Guy's Hospital. Prosector to the Zoological Society. Author of the following papers:—"Report on the Isopoda, collected by H.M.S. *Challenger*" (Parts xxxiii., xlviii.); "Nephridia of Acanthodrilus and of Perichæta" (Proc. Roy. Soc., 1886–87); "Structure of Megascolea" (Trans. Roy. Soc. Edin., 1883); "Minute Anatomy of the Ovary of Echidna"; "Subdivision of the Cœlom in Birds and Reptiles" (Proc. Zool. Soc., 1886–88); "Visceral and Muscular Anatomy of Scopus" (*ibid.*, 1885); "Anatomy of various little-known Types of Birds" (*ibid.*) With other papers on Comparative Anatomy in *Ann. and Mag. Nat. Hist.*, *Ibis*, and *Quart. Journ. Micros. Sci.*

John Ambrose Fleming, M.A. (Camb.),

D.Sc. (Lond.). Professor of Electrical Engineering in University College, London. Late Fellow of St. John's College, Cambridge. Fellow of University College, London. Some time Demonstrator in Applied Mechanics in the University of Cambridge. Author of the following papers, among others:—"The Polarisation of Electrodes in Water free from Air" (Proc. Phys. Soc., 1874); "A New Form of Resistance

Balance" (Proc. Phys. Soc., 1880); "On the Characteristic Curves and Surfaces of Incandescent Lamps"; "On Molecular Shadows in Incandescent Lamps"; "On the Use of Daniell's Cell as a Standard of Electromotive Force"; and "Problems in the Distribution of Electric Currents in Networks of Conductors" (Proc. Phys. Soc., 1885); "On the Necessity for a National Standardising Laboratory for Electrical Instruments" (Proc. Inst. Elect. Engs., 1885); "A Design for a Standard of Electrical Resistance" (Proc. Phys. Soc., 1889); "On Electric Discharge between Electrodes at different Temperatures in Air and in High Vacua" (Proc. Roy. Soc., 1889); "On Some Effects of Alternating Current Flow in Circuits having Capacity and Self-induction" (Proc. Inst. Elect. Engs., 1891). Delivered Friday Evening Discourses at the Royal Institution in 1890-91. Author of "Short Lectures to Electrical Artisans," four editions; and of "The Alternate Current Transformer in Theory and Practice."

CLEMENT LE NEVE FOSTER, D.Sc. (Lond.),

F.G.S., Professor of Mining in the Royal College of Science, and H.M. Inspector of Mines. A.R.S.M. He is distinguished for his knowledge of mining in its various scientific aspects; and is the author of numerous papers bearing on Geology, Mineralogy, and Mine-engineering. He has carried on explorations and mining works in Italy, Egypt, and Venezuela, and was for some years a Member of the Geological Survey of England and Wales, in connection with which he made important discoveries bearing on the question of the denudation of the Weald. His papers are published in the Journals of the Geological and Statistical Societies, and other journals.

HANS GADOW, Ph.D. (Jena),

Hon. M.A. Cantab. Strickland Curator and Lecturer on the Advanced Morphology of Vertebrata in the University of Cambridge. A naturalized British subject, engaged in research in Animal Morphology. Author of "Versuch einer vergleichenden Anatomie des Verdauungssystemes der Vögel" (Inaugural Dissertation, *Jenaische Zeitschr.*, xiii., 1879); "Zur vergleichenden Anatomie der Musculatur der Beckens und der hinteren Gliedmasse der Ratitæ" (4to, Jena, 1880, 5 plates); "Untersuchungen über die Bauchmuskeln der Krokodile, Eidechsen und Schildkröten" (*Morphol. Jahrb.*, vii., p. 57); "Beiträge zur Myologie der hinteren Extremität der Reptilien" (*ibid.*, p. 329); "Observations on Comparative Myology" (*Journ. of Anat.*, 1882, p. 493); "Catalogue of Birds in the British Museum" (vols. viii. and ix.); "On the Colours of Feathers as affected by their Structure" (Zool. Soc. Proc., 1882, p. 409); "On the Reproduction of the Carapace in Tortoises" (*Journ. of Anat.*, 1886, p. 220); "On the Cloaca and Copulatory Organs of Amniota" (Phil. Trans., 1887); "On the Modifications of the First and Second Visceral Arches, with Especial Reference to the Homologies of the Auditory Ossicles" (Phil. Trans., 1888); Volume "Aves" in Bronn's "Klassen und Ordnungen des Theirreichs" (in publication). Conjointly with Dr. Gaskell:—"On the Anatomy of the Cardiac Nerves in certain Cold-blooded Vertebrates" (*Journ. of Physiol.*, v.); "Suctorial Apparatus of the Tenuirostres (1883); "On the Anatomical Differences in the Three Kinds of Rhea" (1885); "On some Points in the Anatomy of *Pterocles arenarins*, with remarks on its Systematic Position (1882). "Introduction to the Osteology of the Mammalia," by W. H. Flower, F.R.S., third edition revised with the assistance of Hans Gadow (1885).

ROBERT GIFFEN, LL.D. (Glasc.),

Assistant Secretary (Commercial Department) Board of Trade. Author of "Stock Exchange Securities: an Essay on General Causes of Fluctuation of their Price" (1878); "Essays in Finance," 1st series (1879), 2nd series (1885); "The Growth of Capital" (1889); also of numerous papers communicated to the British Association, Statistical Society, Bankers' Institute, &c. As head of the Statistical Department of the Board of Trade (since incorporated with the Commercial Department) has been examined by Royal Commissions and Parliamentary or Treasury Committees on the following subjects (among others): Depreciation of Silver (1876); Hall Marking; Wine Duties; Agricultural Depression; Trade Depression; Stock Exchange; Gold and Silver; Channel Tunnel; Emigration and Immigration; Corn Averages, &c. Has given great attention to the theory and practice of the use of Index Numbers in the study of Prices and their history, and first invented and used the plan of an Index Number of a purely objective and not an arbitrary character, especially one based on the actual proportion of the different articles of Import and Export to the total. Has explained with regard to numerous branches of statistics, such as imports and exports, the condition and nature of the data, and the way in which they can be used in public discussions. Has also explained in numerous papers the way in which common statistics can be used in stating and solving problems for the politician, *e.g.* statistics of the growth of population, of the growth of incomes and capital. Has also given attention to the problems relating to the incidence of taxation, upon which several papers are included in the "Essays in Finance." Author of numerous official reports, including reports on wages, prices of imports and exports, emigration, &c.

FRANCIS GOTCH, M.R.C.S.,

B.A., B.Sc. (Lond.), Hon. M.A. (Oxon.). Has made researches of value into the physiology of the nervous system, and is the author of the following papers:—"On the Electromotive Properties of the Electrical Organ of Torpedo" (Phil. Trans., 1887, B., p. 487, and 1888, B., p. 329); "On the Electrical Organ of the Skate," with Dr. Burdon Sanderson, F.R.S. (*Journ. of Physiol.*, vol. ix., p. 137, and vol. x., p. 259); "On the Electromotive Changes in the Mammalian Spinal Cord following Electrical Excitation of the Cortex Cerebri," with Prof. Horsley, F.R.S. (Roy. Soc. Proc., vol. xlv., p. 18); as well as of other shorter papers on similar subjects.

WILLIAM ABBOTT HERDMAN, D.Sc.,

F.R.S.E., F.L.S. Professor of Natural History in University College, Liverpool. Distinguished as a Zoologist, and especially for researches into the structure and relations of the Tunicata. Author of the following, amongst other papers:—"Report on the Tunicata of the *Challenger* Expedition," Parts I., II., and III. (*Challenger* Rept., Zool., vol. vi., 1892; vol. xiv., 1886; vol. xxvii., 188); "On the Invertebrate Fauna of Lamlash Bay" (Roy. Phys. Soc. Edin. Proc., vol. v., 1879, and vol. vi., 1880); "On the Olfactory Tubercle, &c., in Simple Ascidians" (*ibid.*, 1881); "On Individual Variations in the Branchial Sac of Ascidians" (Linn. Soc. Journ., vol. xv., 1881); "The Hypophysis Cerebri in Tunicata and Vertebrata" (Roy. Soc. Edin. Proc., 1883): "Report on the Tunicata of the *Triton* Expedition" (Roy. Soc. Edin. Trans., vol. xxxii., 1883); "Report on the Tunicata of the *Lightning* and *Porcupine* Expeditions" (*ibid.*, 1884); "On the Phylogeny of the Tunicata" (Roy. Soc. Edin. Proc., 1885-86;) "On the Structure of Sarcodictyon" (Roy. Phys. Soc. Edin. Proc., 1884); "On the Structure and Functions of the Cerata or Dorsal Papillæ in some Nudibranchiate Mollusca" (*Quart. Journ. Micros. Sci.*, 1890); and of important Reports on the Fauna of Liverpool Bay, 1886-90.

FREDERICK WOLLASTON HUTTON, Captain, R.E.,

Professor of Geology in Canterbury College. F.G.S., C.M.Z.S., Cor. du Mus. d'Hist. Nat. Paris, Cor. Mem. Roy. Soc. Tas., Hon. Mem. Roy. Soc. N.S.W., Cor. Acad. Nat. Sci. Philad., Cor. Ornith. Ver. Wien., Cor. K. K. Geol. Reichsanst. Wien. Author of numerous reports, papers, &c., published by the New Zealand Government, the Geological and Zoological Societies, the New Zealand Institute, &c., and in the *Phil. Mag.* Amongst them are:—"Fishes of New Zealand," 1872; "Geology of the Thames Gold Field (Government Report, 1868-69); "Sketch of the Geology of New Zealand" (Quart. Journ. Geol. Soc.); "Birds inhabiting the Southern Ocean" (*Ibis*, 1865); "On *Peripatus N. Zealandiæ*"; "On the Structure of *Amphibola avellana*"; "Origin of the Fauna and Flora of New Zealand" (*Ann. and Mag. Nat. Hist.*); "Eruptive Rocks of New Zealand," Oscillations of the Earth's Surface (Aust. Assoc. Advt. Sci., 1889); "On Dimensions of Dinornis Bones" (Trans. N. Z. Inst.); "New Zealand Land Shells"; "Revision of the Land Mollusca of New Zealand" (*ibid.*, vol. xvi.). Author of a Class-book of Geology, and of Zoological Exercises for Students in New Zealand. Author of eleven papers in Proc. Linn. Soc. N.S.W. Has done much valuable work in other ways for the advancement of science in New Zealand.

JOHN JOLY, M.A.,

Assistant to the Professor of Civil Engineering in the University of Dublin. Has discovered (*a*) by direct measurement a variation of specific heat at constant volume of various gases with density; (*b*) Iolite in the Granites of Leinster; (*c*) a heterogeneous Beryl Felspar mineral; (*d*) the reversal of *Oldhamia antiqua* and *radiata* impressions in the Slates of Bray Head. Is the author, amongst other papers, of the following:—"On the direct experimental determination of Specific Heats of Gases at Constant Volume" (Proc. Roy. Soc., vol. xlviii., in abstract, recommended for Phil. Trans.); "On the Method of Condensation in Calorimetry" (Proc. Roy. Soc., vols. xlv. and xlvii.); "On the Specific Heats of Minerals" (*ibid.*, vol. xli.); "Observations of Spark Discharge over Surfaces of Dielectrics" (*ibid.* vol. xlvii.); "On the Volcanic Ash of Krakatoa" (Proc. Roy. Dubl. Soc., vol. iv.). Has invented (*a*) the Method of Steam Calorimetry (Trans. and Proc. Roy. Soc., as above); (*b*) a Diffusion Photometer (*Phil. Mag.*, July 1888); (*c*) a Hydrostatic Balance (*ibid.*, Sept. 1888); (*d*) an Instrument for measuring Melting and Boiling Points of Solids, &c., up to a very high temperature (NATURE, vol. xxxiii., and *Industries*, vol. vi.); (*e*) a Method of measuring the Density of a Gas (*Phil. Mag.*, vol. xxx.); (*f*) a Method of reading Distant Meteorological Instruments (Proc. Roy. Dubl. Soc., vol. iv.); (*g*) a Method of measuring Specific Gravities of Minute Quantities of Porous and other Solids (*Phil. Mag.*, July 1888.

JOSEPH LARMOR, M.A.,

D.Sc. Fellow of St. John's College, Cambridge. University and College Lecturer in Mathematics. Senior Wrangler, 1880. Formerly Professor of Mathematics Queen's College, Galway. Fellow of the Royal University of Ireland. Examiner in Mathematics at the University of London. Author of the following papers:—"Application of Generalized Space Coordinates, Potentials, and Isotropic Elasticity" (Trans. Camb. Phil. Soc., vol. xiv.); "Least Action" (Proc. Lond. Math. Soc., vol. xv.); "Flow of Electricity in Linear Conductors" (*ibid.*, vol. xvi.); "Characteristics of an Asymmetric Optical Combination" (*ibid.*, vol. xx.); "Electro-magnetic Induction in Conducting Sheets and Solid Bodies" (*Phil. Mag.*, 1884); and other papers on Pure and Applied Mathematics.

LOUIS C. MIALL,

Professor of Biology in the Yorkshire College. Prof. Miall has published the following papers and books:—Reports on Labyrinthodonts (Rep. Brit. Assoc., 1873-74): the first translated as introduction to S. Anton Fritsch's "Fauna der Permformation Böhmens"; Fossil Teeth of Ceratodus (Palæont. Indica): Sirenoid and Crassopterygian Ganoids, Part I. (Palæont. Soc.); papers on Labyrinthodonts, Rhizodus, Ctenodus, and Megalichthys (Quart. Journ. Geol. Soc.): Studies in Comparative Anatomy: I. Skull of Crocodile, II. Anatomy of the Indian Elephant (jointly with F. Greenwood), III. The Cockroach (jointly with H. Denny); Vertebrate Palæontology in Geol. Record (Sub-editor). In 1875 received the Wollaston Donation from the Geological Society.

BENJAMIN NEVE PEACH,

F.R.S.E., F.G.S. District Surveyor of the Geological Survey of Scotland. Past President of the Physical Society of Edinburgh. Recipient of the Wollaston Donation Fund of the Geological Society in 1887. For thirty years actively engaged on the Geological Survey, during which time he has mapped many of the most complicated districts of Scotland. Has charge of the surveying of the North-West Highlands, and has taken the leading part in unravelling the remarkable structural complications of that region. Author of various papers on palæontological subjects:—"On some New Crustaceans from the Lower Carboniferous Rocks of Eskdale and Liddesdale" (Trans. Roy. Soc. Edin., vol. xxx., p. 73); "On some new species of Fossil Scorpions from the Carboniferous Rocks of Scotland" (*ibid.*, p. 399); "Further Researches among the Crustacea and Arachnida of the Carboniferous Rocks of the Scottish Border" (*ibid.*, p. 511); "On some Fossil Myriapods from the Lower Old Red Sandstone of Forfarshire" (Proc. Roy. Phys. Soc. Edin., vol. vii. p. 179). Joint author with Mr. J. Horne of many papers on stratigraphical and physical geology, including:—"The Glaciation of the Shetland Isles" (Quart. Journ. Geol. Soc., vol. xxxv. p. 778); "The Glaciation of the Orkney Islands" (*ibid.*, vol. xxxvi. p. 648); "The Old Red Sandstone of Shetland" (Proc. Roy. Phys. Soc. Edin., vol. v. p. 30); "The Glaciation of Caithness" (*ibid.*, vol. vi. p. 316); "Report on the Geology of the North-West of Sutherland" (NATURE, vol. xxxi. p. 31); "The Old Red Sandstone Volcanic Rocks of Shetland" (Trans. Roy. Soc. Edin., vol. xxxii. p. 539); "Report on the Recent Work of the Geological Survey in the North-West Highlands of Scotland, based on the Field Maps of B. N. Peach, J. Horne, W. Gunn, C. T. Clough, L. Hinxman, and H. M. Cadell" (Quart. Journ. Geol. Soc., vol. xliv. p. 378).

ALEXANDER PEDLER,

F.C.S., F.I.C., Fellow of the University of Calcutta; Professor of Chemistry, Presidency College, Calcutta; Meteorological Reporter to the Government of Bengal; and Curator of the Bengal Government Museum at Calcutta. Author of papers on "An Isomeric Modification of Valeric Acid," "Calcutta Coal Gas," "The Use of the Radiometer as a Photometer," "Cobra Poison," "The Past and Present Water Supplies of Calcutta," "Technical Education for Bengal," "The Faln Point Cyclone of September 22, 1885," published in the Proc. Roy. Soc., the Journ. Chem. Soc., the Journ. Asiat. Soc. Beng., and elsewhere.

AUGUSTUS D. WALLER, M.D.,

Lecturer on Physiology at St. Mary's Hospital Medical School. Distinguished as a Physiologist. Lauréat de l'Institut de France (Prix de Physiologie Expérimentale). Contributions to the Royal Society:—"On the Influence of the Galvanic Current on the Excitability of the Motor Nerves of Man" (with Dr. de Watteville, Phil. Trans., 1882); "On the Influence of the Galvanic Current on the Excitability of the Sensory Nerves of Man" (Roy. Soc. Proc., 1882); "On the Action of the Excised Mammalian Heart" (with Dr. Reid, Phil. Trans., 1887); "On the Electromotive Changes connected with the Beat of the Mammalian Heart" (Phil. Trans., 1889). Contributions to the *Journal of Physiology*:—"On the Rate of Propagation of the Arterial Pulse Wave" (vol. iii., 1880); "A Demonstration in Man of Electromotive Changes accompanying the Heart's Beat" (vol. viii., 1887) Contributions to other journals, English and foreign:—"Die Spannungen in den Vorhöfen des Herzens" (*Arch. f. Anat. u. Physiol.*, 1878); "On Muscular Spasms known as Tendon Reflex" (*Brain*, 1880); "Nouvelles Expériences sur les Phénomènes nommés Réflexes tendineux" (with Dr. Prévost, *Rev. Méd. de la Suisse Romande*, 1881); "Sur la Contraction de l'Ouverture" (*Journ. de Physiol.*, 1882), &c.

NOTES.

THE Council of the British Association for the Advancement of Science have nominated Dr. J. S. Burdon Sanderson, F.R.S., Waynflete Professor of Physiology in the University of Oxford, President for the meeting of the Association which will be held next year at Nottingham. Dr. Sanderson has accepted the nomination.

THE Gold Medal of the Linnean Society has this year been awarded by the Council to Dr. Alfred Russel Wallace for his important contributions to the literature of zoology. The medal will be presented at the forthcoming anniversary meeting of the Linnean Society, to be held at Burlington House on the 24th inst.

WE regret to have to record the death of the illustrious chemist, August Wilhelm Hofmann. He died on May 5. Prof. Hofmann was well known in England, where he spent many of his best years. On Liebig's recommendation he was appointed in 1848 Superintendent of the Royal College of Chemistry, in London. This institution, which made great progress under his care, was in 1853 merged in the Royal School of Mines as the Chemical Section. He became a Warden of the Royal Mint in 1855. In 1864 he accepted the chair of chemistry at Bonn, and in the following year he was called to Berlin, where he spent the rest of his life as Professor of Chemistry. He made many contributions to the *Annalen der Chemie*, to the Transactions of the Chemical Society, and to the Philosophical Transactions of the Royal Society, of which latter institution he was made a Fellow in 1851, in recognition of his services to science. In 1854 he was awarded a Royal Medal for his "Memoirs on the Molecular Constitution of the Organic Bases." Some of his discoveries led to industrial results of the highest importance. The high respect in which Prof. Hofmann was held in Germany was shown at his funeral, which took place on Monday. It was very largely attended, and, according to the Berlin correspondent of the *Standard*, "was in all respects worthy of a prince of science." The correspondent says:—"The Empress Frederick, immediately on receiving the news of the Professor's death, telegraphed to his widow, 'My deepest sympathy in your great, your irreparable loss. I am deeply shocked by the quite unexpected news of your dear husband's death.' Her Imperial Majesty sent a splendid laurel wreath bearing her initials, to be placed on the coffin, and a Court Chamberlain represented Her Majesty at the funeral. The Minister of Education and numerous officials of his Department, all the members of the Berlin Academy, and almost all the professors and students of the University, accompanied the funeral procession to the cemetery."

We regret also to have to announce the death of Dr. James Thomson, F.R.S., Emeritus Professor of Civil Engineering in the University of Glasgow, Lord Kelvin's brother. Dr. Thomson died on Sunday last. He was seventy years of age.

There are vacancies for zoological students at the Cambridge University's tables in the Zoological Station at Naples, and in the Marine Biological Society's Laboratory at Plymouth. Applications are to be sent to Prof. Newton, Chairman of the Special Board for Biology and Geology, by May 30.

General Isaac T. Wister, President of the Philadelphia Academy of Sciences, has placed in the hands of trustees for the benefit of the University of Pennsylvania, 100,000 dollars for the erection of a Museum with laboratories, to contain the Wister and Horner Museum of Human and Comparative Anatomy. He has also given an endowment of 3000 dollars a year for the maintenance of a curator, whose occupation shall consist largely of original research.

We referred lately to the interesting Horticultural Exhibition for which preparations were being made at Earl's Court. The Exhibition was formally opened on Saturday last by the Duke of Connaught, and promises to be a great success.

A German scientific expedition under Dr. Erich von Drygalski started from Copenhagen for West Greenland on May 1. Dr. von Drygalski is accompanied by Dr. H. Stade, the meteorologist, and Dr. E. Vanhöffen, the zoologist. They were to make in the first instance for Umanak Fjord. They do not intend to return until the autumn of 1893.

We are glad to welcome a third edition of Clerk Maxwell's great "Treatise on Electricity and Magnetism" (Clarendon Press). The task of seeing the proofs through the press could not be undertaken by Mr. W. D. Niven, who had charge of the second edition; so the duty has been fulfilled by Prof. J. J. Thomson, who, we need scarcely say, has done his work admirably. Twenty years have passed since the work was written, and during that time the sciences of electricity and magnetism—thanks in part to the influence exerted by this treatise—have made rapid progress. Prof. Thomson explains that when he began to prepare the present edition he intended to give in foot-notes some account of the advances made since the publication of the first edition, not only because he thought it might be of service to students, but because all recent investigations have tended to confirm in the most remarkable way Maxwell's views. He soon found, however, that if this intention were carried out the book would be disfigured by a disproportionate quantity of foot-notes. His notes have accordingly been thrown into a slightly more consecutive form, and will be published separately. A few foot-notes relating to isolated points which could be dealt with briefly are given. Prof. Thomson has added something in explanation of the argument in those passages in which he has found from his experience as a teacher that nearly all students find considerable difficulties. He has also attempted to verify the results which Maxwell gives without proof. He has not in all instances succeeded in arriving at Maxwell's results, and in such cases he has indicated the difference in a foot-note. Maxwell's method of determining the self-induction of a coil is reprinted from his paper on the dynamical theory of the electro-magnetic field.

At the time of our last issue, an anticyclone lay over the whole of the British Islands and part of the Atlantic, with north and north-east winds of some force, under the influence of a depression existing over North Germany. Daily temperatures were, generally, considerably below the normal values; slight snow fell on the south coast on the morning of the 6th, and the grass thermometer fell as low as 18° on that night in London. The anticyclone afterwards moved southwards, while a depression, which had set in at the northern stations, spread towards the North Sea, the winds shifted to west and north-west, and temperatures gradually increased; the maxima exceeded 60° over the inland parts of England on Sunday, and even reached 70° at several stations on Monday, with fine weather generally. The amount of rainfall is considerably below the average. The Weekly Weather Report for Saturday last shows that the deficiency, since January 3, amounts to 7·7 inches in the west of Scotland and to 5·3 inches in the south-west of England. During the last few days this country has again been under the influence of an anticyclone, with fine, warm weather generally.

The Pilot Chart of the North Atlantic Ocean, in its review of weather during April, says that the storms on the Atlantic, like those of the preceding month, were confined almost entirely to the American coast and the western part of the ocean, and they again followed somewhat abnormal northerly tracks. Two of the most severe storms whose tracks are plotted on the chart, occurred during the last few days of March. During the first week of April, pleasant anticyclonic weather prevailed along the American coast south of Hatteras, but two severe storms moved eastward over Labrador on the 3rd and 6th respectively, the first of which was followed by a storm of slight energy that formed south of Cape Race on the 4th, and the second by one that reached Hatteras from inland the morning of the 8th, but neither of these, nor those of the 9th to 11th, and 15th to 16th, along the Nova Scotia coast, were at all severe. The only remaining storms of any noteworthy severity, so far as indicated by data received at the office of the Pilot Chart up to date of publication, were those that originated between the Grand Banks and Bermuda on the 13th and 18th respectively. The track of a depression of considerable energy is indicated near the Azores on the 6th, 7th, and 8th, and another, but of slight energy only, in the English Channel on the 15th and 16th. The persistent anticyclonic weather over the British Isles and Central Europe during the last week of March and the first half of April, may be said to have turned to the northward the storms that formed over the ocean, and it seems probable that the persistent northerly winds thus caused off Labrador and Newfoundland helped along the ice that is now working its way southward off the Grand Banks. Fog has been reported in increasing quantities, also, and it will continue to increase until midsummer.

We note the publication of two new monthly meteorological bulletins for Russia, which are issued nearly closely up to date, viz. by Prof. A. Klossovski, Odessa, with Russian and German next, and by Prof. P. Brounof, Kieff, in Russian, with a few notes in French. Both bulletins contain observations taken three times daily, with daily and monthly means, while the Odessa publication contains monthly rainfall values, and maximum and minimum temperatures for about a hundred stations in South-West Russia. The Kieff observations are preceded by some remarks (in Russian only) on the temperature and density of snow at various depths.

A REMARKABLE aurora borealis was seen at Moscow during the night of April 26–27. It began at 11.50 p.m. with a dark segment fringed by a bright border, the summit of which stood a few degrees to the west of the meridian. Bright rays were projected to the constellations of Auriga, Perseus, and Cassiopœia, while the longest rays reached the Pole star. It attained its maximum at 11.56, but four minutes later it began to die away, no traces of it being seen at 12.15 a.m. At 2 a.m. three beams of light appeared again for a few seconds. It is worthy of note that on April 26 a large accumulation of sun-spots was observed at Moscow; it consisted of ten groups of spots. It may also be added that another aurora borealis, much brighter than the above, was seen at Moscow on March 12, at 4 a.m. It lasted for nearly half an hour.

ALL who have occasion to use the magic lantern will be interested in the fact that a lantern may now be seen at the Crystal Palace finely illuminated by the arc-light. This instrument was designed by Mr. T. C. Hepworth, F.C.S., who uses it to illustrate lecture entertainments in connection with the Crystal Palace Electrical Exhibition. The lamp employed is the Brockie-Pell, which has been modified by Messrs. Newton to make it more suitable for the particular work required. It gives a pure white light, and its brilliance is said to be several times that of the lime-light. The electric arc-light has before been applied to lantern projection, but it is claimed that the Crystal Palace lantern is on quite an unprecedented scale.

M. MESDRAN, of Paris, sends us a prospectus, in which he sets forth the merits of a machine he has invented for the proper boiling of eggs. Hitherto, it seems, mankind have boiled eggs on a wholly false principle. M. Mesdran claims that he has solved the problem, and that his invention is nothing short of "a revelation both from the hygienic and the gastronomic point of view." The invention has been patented in England.

AN interesting trace of Palæolithic man has lately been discovered in Hermann's Cave in the Harz. Excavations were being carried on in the cave, under the superintendence of Herr Grabowsky, when a flint which had all the appearance of having been fashioned into the form of a knife was found among the remains of reindeer and other glacial or Arctic animals. The object could not have been brought into the cave by non-human means, as flint is not found anywhere in the neighbourhood. A paragraph on the subject appears in the current number of *Globus*, the editor of which appends a note to the effect that the flint (which lay before him as he wrote) has undoubtedly been artificially worked into its present shape.

DR. DANIEL G. BRINTON has issued an interesting pamphlet, in which he urges the claims of anthropology as a branch of University education. He gives an account of the aims and methods of the science, and then sketches a general scheme of anthropological instruction. Dr. Brinton would begin with lectures on somatology, including internal somatology, external somatology, psychology, and developmental and comparative somatology. Then would come ethnology, in connection with which he would deal with sociology, technology, religion, linguistics, and folk-lore. Under ethnography he would discuss the origin and subdivisions of races; and archæology he would divide into "general" and "special." Laboratory work would include (in the physical laboratory) such tasks as the comparing and identifying of bones, the measuring of skulls, &c.; and (in the technological laboratory) the study of stone and metal implements, textile materials, &c. There would also be library work and field work. Students who might wish to obtain an adequate notion of the science would have to attend a course of thirty or forty lectures, and give twice as many hours to laboratory work. That would be the minimum amount of study. Those who might desire to instruct others, or to prepare for independent research, would devote to the science the greater part of their time during two or three years.

THE structure of the cells of Bacteria continues to occupy the attention of biologists, and a communication on the subject to the St. Petersburg Society of Naturalists (*Memoirs*, vol. xxi., Botany), by W. K. Wahrlich, is worthy of notice. Careful study of several species of Bacteria has led the author to the conclusion that only two substances are to be detected in the cell—chromatin, and linin, which surrounds the former. The leading part in the formation of spores belongs to chromatin, which is used entirely for this purpose, while the linin substance is used for the formation of the exosporium. As to the involutional forms, the author can only confirm the opinions of De Bary, Nägeli, and Büchner as to their being representative of a pathological state, or of a degeneration of the cell; chromatin disappears in such cells, and two or three vacuoles appear in their linin part. The bacterial cells thus appear to be simple nuclei, surrounded by membranes, but devoid of cytoplasm; chromatin is their most important part, and when it disappears the cell can no longer reproduce itself or continue an independent life.

A REPORT was lately spread in the United States to the effect that the Government intended to introduce the mongoose in the West to exterminate the rodents which annoy farmers there. The editors of the *Naturalist* wrote to the Department of Agriculture for information on the subject, and received in reply a letter to the effect that no such "rash act" had ever been contemplated, the introduction of exotic species being contrary to the Department's policy. The *Naturalist* expresses cordial approval of this answer, evil having, it maintains, "invariably resulted from the introduction of exotic animals into countries when no adequate natural restriction to their increase exists."

MR. F. W. WARD was commissioned last year by the Hon. Sydney Smith, then Minister of Agriculture in New South Wales, to report upon the relations of fruit production in that colony to the English market. The report was presented some time ago, and is printed in the February number of the *Agricultural Gazette of New South Wales*. Mr. Ward is convinced that London offers an attractive market for the fruit products of Australasia in their green, dried, and canned forms. All testimony, and most emphatically that of the European growers, is, he says, to the effect that London is, and always will be, the great fruit market of the world. There is also, he adds, a consensus of opinion to the effect that Australasia will gain the largest share of the advantage in regard to this market, consequent upon the reversal of the seasons. Other territories in the southern hemisphere will dispute the market with Australasia; but Mr. Ward anticipates that the energy and intelligence of Anglo-Saxon communities, operating upon good and cheap soil, an unsurpassed, if not an unrivalled, climate for fruit production, and splendid facilities of over-sea carriage, will fully or more than compensate for the one great disadvantage of geographical distance. The London market for Australasian fruit resolves itself, for the most part, into a question of carriage. What needs to be done is to minimize the cost of conveying green fruit from (say) Sydney to London, and to solve the chemical problems attaching to the attempt to utilize the cool chambers of swift steam-ships in such a way as to preserve the appearance and flavour of so perishable a commodity as fruit through the unavoidable space of time and varying latitudes of the journey. Mr. Ward is of opinion that there are sound reasons for expecting that "these problems will be solved and that the market will be captured."

The Echinoderm fauna of Kingston Harbour, Jamaica, seems to be remarkably numerous and varied. Mr. George W. Field, who has been investigating it, contributes some notes on the subject to the April number of the "Johns Hopkins University Circulars." About twenty-eight species of Echinoderms were found in Kingston Harbour and about the cays at its mouth, and a longer residence and dredging in the deeper waters would probably, Mr. Field thinks, have increased the number considerably. The difficulties of dredging were very considerable, arising in part from the nature of the bottom, from the unmanageableness of the boat, and chiefly from the wind. There always seemed to be a perfect calm or a gale; the calm periods between exceedingly short. However, considerable dredging was done by various members of his party. The surface tow-net showed a wonderful richness of the larval Echinoderms in the pelagic fauna, chiefly however, during their stay, confined to Ophiurid, Echinid, and Spatangid plutei, the relative abundance being in the order named. During the month of June they were abundant, and in early July they were extremely numerous. They were found in greatest numbers in tows made about sunrise. In the evening towing they were invariably absent. These larvæ, says Mr. Field, appear to come to and remain at the surface from midnight until about sunrise; after that to gradually disappear until three hours after sunrise, when they are rarely found at the surface. Their appearance seemed to be little or not at all influenced by the tide, but did depend very much upon the quantity of flood water poured into the harbour by the various rivers. In its general aspect the Echinoderm fauna shows no very considerable variation from that of the Bahamas and Southern Florida, though apparently richer in species and in individuals.

According to an official report published in the *Deutsches Kolanialblatt* for April, the Germans have every reason to be satisfied with the way in which the resources of Cameroon are being developed. The industry and trade of the colony are said to be in a flourishing condition. The chief products are palm oil and palm kernels. There are many elephants in the territory, and ivory is still exported. Caoutchouc is also obtained in considerable quantities, and ebony fetches good prices. In 1891 there were in Cameroon 166 Europeans, of whom 10 were women. There were 109 Germans and 31 Englishmen. The exact number of natives is not yet known, but it is calculated that there are 20,000 Dualla on the Cameroon river, 25,000 Bakwiri in the Cameroon Highlands, and 20,000 Bamboko towards the west of the hilly district.

A valuable paper presenting a revision of the American species of Rumex occurring north of Mexico, by William Trelease, appears in the third annual report of the Missouri Botanical Gardens, and has also been issued separately. Rumex is a genus which has been held to include from 100 to about 130 species, the greater part of which belong to the north temperate region of both continents. "Of the twenty-one species," says Mr. Trelease, "recognized by me as occurring within our flora, eleven were characterized and named by Linnæus in the first edition of the 'Species Plantarum,' and only five have been named by American botanists." The biological interest of the genus arises chiefly, as he points out, from the protective acidity of the sorrels and some docks, and the occurrence of tannin and a bitter principle in others; their protandry and exclusive adaptation to wind pollination; and the adaptation of the greater number of species to wind dissemination, by the enlargement of the inner segments of the perianth during ripening, although some of those with fimbriate valves may profit by attachment to animals.

In the latest instalment of the Proceedings of the Academy of Natural Sciences, Philadelphia, Messrs. H. Skinner and L. W. Mengel give an account of some of the insects taken by the expedition which the Academy sent to Greenland in 1891. The insects captured were divided among the different orders as follows:—Hymenoptera 25 specimens, Coleoptera 4 specimens, Lepidoptera Rhopalocera 143 specimens, and Heterocera 143. They were captured by Mr. L. W. Mengel, entomologist to the expedition, and Dr. W. E. Hughes, ornithologist. The specimens are all from the West Coast, and were taken at three principal localities, McCormick Bay, Herbert Island, and Disco.

Acetyl fluoride, CH_3COF, has been prepared by M. Maurice Meslans, and is described by him in the current number of the *Comptes rendus*. As was to be expected, it is a substance considerably more volatile than acetyl chloride. Its boiling-point is 19°·5, very near that of hydrofluoric acid itself, and hence upon a warm day it takes the form of a gas, while at temperatures below 19°·5 it assumes the liquid state. It has been prepared by M. Meslans by causing various inorganic fluorides to react upon acetyl chloride. Thus when silver fluoride and acetyl chloride are heated together in a sealed tube to 260°, a small quantity of acetyl fluoride is formed. The acetyl chloride, however, is much more completely converted to fluoride when it is passed in the state of vapour through a long silver tube filled with dry silver fluoride and heated to 300°. Upon allowing the issuing vapour to pass into a strongly cooled receiver, acetyl fluoride condenses in the liquid form. Another mode of preparation consists in allowing arsenic fluoride to fall drop by drop upon acetyl chloride contained in a copper vessel, when energetic action at once occurs in the cold. The exit tube is attached to a spiral of leaden tubing, arranged as an inverted condenser, in order to retain either of the liquid reacting substances, and the last traces of acetyl chloride are removed by subsequently allowing the escaping vapour to pass through a copper U-tube filled with fragments of silver fluoride and heated in a bath of nitrates to 300°. The acetyl fluoride may then be condensed in a strongly cooled receiver. Instead of arsenic fluoride the solid trifluoride of antimony may be employed, and the operation performed in a glass flask, an ordinary inverted glass condenser being used to retain any escaping acetyl chloride. By far the most advantageous mode of preparation, however, consists in reacting with acetyl chloride upon zinc fluoride. One hundred grams of zinc fluoride are introduced in successive portions of ten grams each into a strong glass flask cooled by a freezing mixture and containing a hundred and fifty grams of acetyl chloride. The flask is then sealed, warmed to 40°, and again cooled. It is subsequently opened, while surrounded by the freezing mixture, and placed in connection with a leaden worm whose extremity passes down into a second flask surrounded by ice and containing a little dry zinc fluoride. The acetyl fluoride is then distilled over into the second flask, and upon redistillation over the zinc fluoride contained in the flask it is obtained in an almost pure condition. The liquid may be preserved unchanged in a dry glass vessel, but if moisture obtains access the glass is rapidly attacked. If the vessel containing the liquid is placed in connection with a tube standing over mercury, and the liquid warmed by holding the vessel in the hand, the new fluoride may be collected in the gaseous state, and preserved as a gas, provided the temperature of the room is superior to 19°·5. Both the liquid and the gas are colourless.

They burn with a blue flame upon ignition, producing water vapour, carbon dioxide, and hydrofluoric acid. They possess an odour somewhat resembling that of carbonyl chloride. Water dissolves about twenty times its volume of the gas, but the liquid does not mix with water, a very small proportion only being dissolved, and suffering slow decomposition. Alcohol, ether, benzene, and chloroform dissolve it in all proportions.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Mr. C. Drew; a Grivet Monkey (*Cercopithecus griseo-viridis* ♀) from North-east Africa, presented by Mr. George Conquest; a Grey Ichneumon (*Herpestes griseus*), from India, presented by Mr. J. E. Barber; a Common Fox (*Canis vulpes* ♀), British, presented by Miss Nora Dunn; a Song Thrush (*Turdus musicus*), British, presented by Mr. Baldwin M. Smith; an Alexandrine Parakeet (*Palæornis alexandri* ♂) from India, presented by Mr. E. Bond; two Cerastes Vipers (*Vipera cerastes*) from Egypt, presented by Colonel Holled Smith; a —— Lizard (*Amphibolurus* sp. inc., from Australia, presented by Mr. Herbert E. Swayne; a Guinea Baboon (*Cynocephalus sphinx* ♀) from West Africa, a Rhesus Monkey (*Macacus rhesus* ♂), a Grey Ichneumon (*Herpestes griseus*) from India, two Punctated Agoutis (*Dasyprocta punctata*), a King Vulture (*Gypagus papa*) from Central America, a White-eyebrowed Guan (*Penelope superciliaris*) from South-east Brazil, deposited; a White-faced Heron (*Ardea novæ-hollandiæ*) from Australia, eight Ruffs (*Machetes pugnax* 4 ♂ 4 ♀), British, purchased; a Reindeer (*Rangifer tarandus* ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

PHOTOGRAPHIC AND VISUAL MAGNITUDES OF STARS.—At the Amsterdam Academy of Sciences on April 2, Prof. J. C. Kapteyn communicated the results of an investigation on the systematic differences between the photographic and visual magnitudes of stars in different regions of the sky. The comparison of the photographic diameters of stars of equal visual magnitude (according to Gould and Schonfeld's estimations) on 370 plates of the southern sky, shows that the actinic effect of stars in or near the Milky Way is much greater than that of stars in high galactic latitudes. Prof. Kapteyn has examined the different causes which lead to this variation. There is, first of all, the influence of different meteorological conditions; next, systematic errors in the catalogue of visual magnitudes used for comparison; and thirdly, peculiarities in the light of the stars. The discussion leads to the conclusion that the difference of magnitude is not appreciably affected by the first of these causes. And since, taking everything into consideration, the errors of estimated visual magnitudes could not possibly exceed 0·3 magnitude, there is no doubt that the difference of half a magnitude or more, indicated by the photographs, is due to the quality of light emitted. It is said that Prof. Pickering's idea that the Milky Way ought to be considered as an aggregation of stars of the first type is only sufficient to account for a difference of about 0·1 magnitude. Thus it appears that the light of stars in or near the Milky Way, like those of Group IV., is richer in violet rays than that of other stars.

PHOTOGRAPHS OF THE LYRA RING NEBULA.—In addition to the work on the Carte du Ciel, Prof. Denza, of the Vatican Observatory, has taken up the photography of nebulæ. Beginning with the Ring Nebula in Lyra, he has made five exposures on this object, from half an hour up to nearly two hours' duration. To bring out the fine detail, development has been carried on for about twenty minutes in each case. The negative which had received the longest exposure was presented to the Paris Academy on April 25. Viewed microscopically, the star at the centre of the nebula is seen to be joined to a smaller one near the nebulosity, and each of them can be broken up into other more or less brilliant points. A large number of condensed regions are well visible in the nebula. The location of these leads Prof. Denza to agree with Secchi that "L'anneau se prolonge dans le sens du plus grand axe, et que les parties les plus denses sont dans la direction du petit axe."

DETERMINATION OF THE CONSTANT OF ABERRATION.—Prof. G. C. Comstock contributes the provisional results of a determination of the constant of aberration to the *Astronomical Journal*, No. 261. The method adopted in the investigation is a modified form of that used by M. Lœwy, three reflecting surfaces being placed in front of the objective of the telescope instead of two. Images of stars in different portions of the heavens are thus simultaneously produced in the focal plane of the objective, and a micrometer is used to measure the distance between those of two given stars, when each pair of surfaces is successively employed. Then, if d represent the distance between the images of two stars as measured with the micrometer, Δ the angle subtended at the earth by the stars, R the effect of refraction in changing the true Δ into an apparent Δ', and K a correction depending upon the squares of the errors of adjustment of the mirrors, we have—

$$\Delta = 120^\circ + K + d + R.$$

The provisional value of the aberration constant derived from Prof. Comstock's observations is—

$$20''{\cdot}494 \pm 0''{\cdot}017.$$

An investigation of the refraction has also been made, resulting in the detection of a real variation. The refraction is at a maximum near the time of the winter solstice and a minimum near the summer solstice, but the exact epoch and amplitude have not yet been determined.

STAR MAGNITUDES.—"The Estimation of Star Magnitudes by Extinction with the Wedge," was the subject of an interesting paper by Captain Abney before the Royal Astronomical Society, many of the experiments from which his conclusions were drawn being made from a paper which he and General Festing communicated to the Royal Society on colour photometry. In the experiment for determining the amount by which the intensity of any ray of the spectrum would have to be reduced before it became invisible, the absolute intensity of the D line was fixed upon for the basis, from which all the other intensities could be directly calculated. With the arrangement he described, the D line was reduced to the 350 ten-millionths part of a standard amyl lamp, while under the same conditions the green light E had to be reduced to 65, F to 150, G to 3000, and the red to 110,000 ten-millionth part. By making the rays equal to one amyl lamp the numbers obtained were for D 350, E 35, F 17, G 15, and for C 22,000 ten-millionths part.

These numbers showed that to produce extinction for two lights of equal luminosity, say of colours C and G respectively, the latter was nearly 1500 times greater than that required for the other. He then referred to the extreme persistency of the violet sensations, they being 1500 times more persistent than the red and about 25 times more than the green, pointing out that the violet sensation would be the last to be extinguished. The function of the wedge, then, was not to obliterate the spectrum but to eliminate the violet sensation contained in its light. By determining star magnitudes by this method of extinction, the results obtained, he says, "should agree better with those obtained by photography than those obtained by eye estimation," the first being obtained by estimation of the E light, the second of the light between G and F, and the third from that near D.

Referring to colour extinction he mentions that although most of the faint stars are known to be of a bluish colour it does not follow that "they are not red." The blue tint is brought about by the faintness of the light, which makes all colours appear grey, and "as the violet sensation disappears last, it frequently happens that you get the red and green sensations as grey, and the violet just above the colour limit, thus giving a grey blue." He suggests that with telescopes of large aperture these stars might be seen in colours.

THE INSTITUTION OF MECHANICAL ENGINEERS.

AN ordinary general meeting of the Institution of Mechanical Engineers was held on the evenings of Thursday and Friday of last week. There were two items of exceptional interest on the programme, the first being the inaugural address of the new President, Dr. William Anderson, F.R.S.; and the second the report of the Committee appointed by the Institution to make trials on marine engines. The President in his address gave a brief review of the progress of the Institution since its foundation in 1847. For the first thirty years of its existence the Institution was a provincial Society, having its head-quarters in Birmingham. In 1877 it was determined to remove to London, as it was thought that the wealth and influence that had been acquired was sufficient to give a position of national importance which could hardly be held by a Society having its head-quarters in any other city than the metropolis. There was naturally a strong opposition to the migration, but the change was made, and since then the importance of the Institution has gone on steadily increasing, until at the present day it is second only to the Institution of Civil Engineers. The Institution was started in 1847 with 107 members, the annual income being £515. During the first thirty years the membership increased about tenfold, but at the end of the fourteen years that the head-quarters have been in London it has increased to twenty-fold; that is to say, in 1877, when the migration was made, the numbers were about one thousand, whilst last year they were over two thousand—actually 2077. The annual income was last year £7212, and the accumulated investments of the Institution are now £22,536.

A somewhat acrimonious correspondence has been published lately in the pages of a weekly journal, and the President, somewhat unnecessarily perhaps, thought fit to reply to this. A complaint had been made that the papers were few and poor. Dr. Anderson referred to the large number of scientific Societies now existing, and the difficulty of providing good papers. "We have been spoiled and cloyed," he says, "by the rapid progress of mechanical engineering; so that papers which are not revelations of something new are condemned as unworthy of the Institution. Is there any form of steam-engine, for example, which it would be worth while now to describe, unless it be some monster of exceptional proportions, the details of which we should like to see in our Transactions? Who would like to read a paper on a bridge of even 800 feet span, and to illustrate it with all the type and plates which characterized the two accounts of the Britannia Bridge, when the Forth Bridge, a structure of more than double that opening, has recently become familiar to us? I am afraid that, in consequence of the state at which we have arrived, and, in respect of originality, the untoward age in which we live, we must be content with many papers that may justly be termed poor so far as novelty alone is concerned. We must, therefore, rely for excellence on a more scientific treatment of our subjects, and on the care with which the details of construction are worked out and presented in the illustrative drawings. Our critics should remember also that originality is not our only quest—that we are not all veterans to whom design comes almost by instinct: we have a large body of younger and less experienced members, and to them I feel sure, from my past experience, that our proceedings offer practical examples and guidance which are appreciated all over the world, and the desire to possess which is, I take it, the main cause of the ever-increasing strength of the Institution."

The President next referred to the work done by the different Research Committees of the Institution which have been engaged for some years past in investigating engineering subjects upon which information appeared most desirable. There have been Committees on riveting, on friction, on steam-jacketing engine cylinders, and other matters, including marine-engine trials, the last report of the Committee on the latter subject having been presented at the meeting now under notice. It would be difficult to imagine a more useful and legitimate purpose upon which the funds of the Institution could be spent. The work that is over and over again done, generally in a partial and imperfect manner, by private firms, in getting information on many points of engineering practice, represents a sad loss of time and money. The work of the Research Committees of the Institution should put an end to a great deal of this, and will so help the advance of engineering practice, to the benefit not only of engineers, but of the whole civilized world. The President made another suggestion which would tend to the same end, and which it is hoped may be carried out. "There is," he said, "another sphere of usefulness in which our abundant means would enable us to do good service; it is in the compilation of a brief reference index to all mechanical matters at home and abroad. Were we to establish a staff—and it might be a very modest one—whose duty it would be to index under proper heads every important article relating to mechanical science which comes out week by week, we should in time, and at moderate cost, form an invaluable record, from which an inquirer would be able to find in a few minutes where to look for complete information on any subject connected with our special branch of engineering." The Royal Society is doing a similar work for scientific papers generally; and in the United States Messrs. Haferkorn and Heise have compiled a most useful index of books printed in English relating to technical matters, but the work stops at 1888, and does not contain references to the isolated letters and papers which appear in English and foreign journals.

Dr. Anderson, as every one knows, holds the important post of Director-General of Ordnance Factories, and it was natural he should make some reference to the various establishments—the chief of which, of course, is Woolwich Arsenal—under his control. Here, again, public criticism has been exercised of late, not altogether favourably, and a good part of the address was taken up with an apology for Woolwich. Taking the side of the case selected by Dr. Anderson for discussion, there is no doubt he made out a very good case. It is perfectly impossible that all inventions should be adopted, and therefore it is evident the authorities with whom these matters rest must reckon with a great many hostile critics. The address gave some interesting details of the way in which the Ordnance departments are managed, but into this question we need not now enter. The difficulty of finding subjects for papers which were altogether novel had been previously referred to in the address; but, notwithstanding that there is little scope for originality, Dr. Anderson pointed out that some problems still remain to be solved. Among them is one which is of the greatest practical importance to mechanical engineers, while at the same time it is of extraordinary theoretical interest. This was the question of the nature and composition of steel, and alloys generally. Since the year 1879 the Institution had been engaged in trying to unravel the mystery which surrounds the behaviour of steel in connection with its chemical and molecular composition, combined with changes of temperature. The researches of Sir Frederick Abel, Dr. Sorby, Mr. Osmond, Mr. Hadfield, and Prof. Roberts-Austen, aided by the Le Chatelier pyrometer, have given the inquiry new life. Dr. Anderson expressed great hope that the active measures taken by the Institution, through the Alloys Research Committee, would result, at no distant time, in the solution of the enigma, and in the establishment of definite laws. The problem, however, is excessively involved. It amounts, in fact, to a consideration of the number of permutations or combinations possible among some ten variables, the relations of which to each other are also dependent, not only on actual temperature, but also on the rate of its changes, and on the uniformity of these changes, throughout the mass. The address next made reference to the fact that pure iron is allotropic, and exists in both the hard and soft state. Carbon also exists in two forms in steel, either combined or suspended in the mass; and there are other ingredients necessary to take into account. In consequence of changes due to temperature also, the chemist is impotent to pronounce from mere analysis what the quality of steel may be. On the other hand, the ordinary mechanical tests are not of much avail, because the specimens are not and cannot be in the same condition of internal stress—on which again the molecular arrangement appears to depend—as the masses from which they are cut. Moreover, specimens for mechanical testing cannot always be taken from the central parts of the huge forgings and castings now in use for many purposes. Under these circumstances Dr. Anderson considered that the method of noting the rate of cooling by curves automatically traced—as now so ingeniously worked out by Roberts-Austen—affords the best promise of placing in the hands of the mechanic a means of judging at any rate of the uniformity in composition of the material, and even perhaps of its actual chemical nature, so far as this affects his wants. As additional advantages the thermo-electric autographic apparatus is cheap; it occupies but little space, it can be employed in an ordinary room, and the results sought can be obtained in a few minutes.

The use of petroleum or mineral oil next occupied a place in the address, the author being of opinion that as a source of power it would rapidly gain ground. In 1888, Priestman Bros. brought out their engine, working with a heavy oil having a high flashing temperature. That engine was tested by the present Lord Kelvin (then Sir William Thomson) and the author independently, and gave an efficiency of one brake horse-power to 1·73 lb. of oil. At the next year's show the consumption fell to 1·42 lb.; in 1890, to 1·243 lb., and Prof. Unwin this year reports that a brake horse-power has been obtained by the combustion of 0·946 lb. Much yet remains to be done. The useful work on the brake is under 14 per cent. of the energy latent in the fuel, while the heat carried off by the water jacket round the cylinder, and by the exhaust is equivalent to 75 per cent. of the total thermal capacity of the fuel. Dr. Anderson was of opinion that a combination of the direct combustion engine with the spirit-engine of the Yarrow type would give the best results, especially if a more advantageous cycle than that of the Otto gas-engine can be adopted.

The address next proceeded to deal with the question of the capacity of the earth to supply the ever-increasing demand for petroleum, and to enquire whether it would be possible to substitute it largely for coal as a source of heat, owing to the fact that we should have to go deeper and deeper in the future to reach workable coal measures. In connection with this problem the address gave particulars of the researches of Mendeleeff, and described his theory of the continuous formation of petroleum by the action of water on the molten rocks in the interior of the earth. The speculation is one of great interest, but has already been dealt with in these pages.

The vote of thanks to the President for his address was moved by Sir Frederick Bramwell and carried with acclamation.

After the reading of the address the Report of the Marine Engine Trials Research Committee, which had been prepared by the Chairman of the Committee, Prof. Alexander B. W. Kennedy, was read. This report dealt with the trials of the Belgian channel steamer *Ville de Douvres*, which had been generously placed at the disposal of the Committee by the Belgian Government. This vessel is one of the line which carries the mails between Ostend and Dover, and was built and engined by the Société Cockerill, of Seraing, Belgium, and is a comparatively new vessel, having been delivered in the year 1890. The propelling machinery consists of a pair of compound surface-condensing paddle engines. Vessels of this class are mainly designed with a view to speed, as the chief object desired is to carry passengers and mails quickly from port to port. As the run is only of three hours' duration, it would obviously not pay to enter into any refinements with a view of economizing fuel. The time under way is comparatively small when considered in relation to the time spent in raising steam and cooling down again. This is a point which should be borne in mind, but which some critics appeared to forget during the discussion. Perhaps engineers are apt to base their estimates of efficiency, especially in marine practice, too much on an economy basis. It is a good thing to save fuel if it can be done without too much sacrifice. An examination of the details of the various trials of steamships made by the Research Committee illustrates this important point. We hardly know how to deal with this paper. It is full of information of the most valuable description, but its very fullness renders it extremely difficult to make an abstract, and we have not space to give all the details in full. Perhaps the best plan will be to give some of the leading facts; and, although these may appear somewhat bald standing alone, they will enable our readers to form an estimate of the scope of the trials, and those who are especially interested will go to the original, in the Transactions of the Institution, for fuller details. The *Ville de Douvres* is 271 feet long, 29 feet broad, and 15·5 feet deep, moulded. Her registered tonnage is 855 gross; and her displacement 1090 tons. She was run for nine hours especially for the trial in the North Sea. The engines are of the compound inclined, surface-condensing type, with cylinders 50·12 inches and 97·12 inches in diameter, with 72 inches stroke. Neither cylinder is steam-jacketed, but there is an intermediate receiver encircling the high-pressure cylinder; an arrangement which certainly does not tend towards efficiency. The air, feed, and bilge pumps are driven from the main engines. The circulating pump is separate, and is estimated to develop 47 indicated horse-power. The surface condenser contains 6540 square feet of tube surface, and it is so arranged that the circulating water passes three times through the condenser. The course of the water is such that the coldest water meets the hottest steam. This is naturally not the best arrangement, for the circulating water would still be efficient for taking heat from the hottest steam, even after it had been somewhat raised in temperature by the coldest steam. On the other hand, circulating water having been heated by the steam at highest temperature, will be comparatively inefficient to further cool down steam already cooled to a great extent. In any case, if a good vacuum be ultimately obtained, the refrigerating surface will be far less effective. The paddle-wheels are 22 feet 10 inches over the floats, the latter being 10 feet broad and 4 feet 4 inches deep. The immersion on trial was 17 inches. There are four single-ended return-tube boilers, 13 feet by 10 feet. The grate area is 236 square feet, and the total heating surface 7340 square feet. There is forced draught on the closed stokehold system. The total weight of all machinery, exclusive of paddle-wheels, and all water is 361 tons. Block fuel was used throughout the trial. The calorific value, calculated from analyses made, was 14,390 thermal units per pound. This corresponds to an evaporation of 14·90 pounds of water from and at 212° F. A number of samples of furnace gases were collected and analyzed, with the following mean results:—

	Carbonic Acid.	Carbonic Oxide.	Oxygen.	Nitrogen.
By volume per cent. ...	11·55 ...	0·00 ...	7·95 ...	80·50
By weight per cent. ...	16·84 ...	0·00 ...	8·44 ...	74·72

There was a little uncertainty about the temperature of the chimney gases, but the mean temperature was assumed to be 910° F. The mean draught was equal to a pressure of from 0·92 to 1·22 inches on the water-gauge. A notable feature about these trials was that the feed measurement was made by meters. This is a vast improvement, in one respect at least, and that of great importance, on the measuring tank system. Measuring tanks are always cumbersome and difficult to fit; so much so that they generally prove the greatest bar to proper trials being made of the efficiency of marine machinery. The meters used were of the Kennedy type, and appear to have answered the purpose admirably. There is no trouble in taking a meter reading, whilst the measuring tanks require constant attention. We look on the introduction of the water meter for this purpose as a most important step in advance, and one which will lead to engineers obtaining more frequent information on the efficiency of marine engines. It is most desirable that the performance of the boiler should be separated from that of the engine. The indicated horse-power and coal consumption give the economy of the whole machine; but when results are not satisfactory it is often difficult to say whether the fault rests in the boiler compartment or the engine-room. Another step in advance is the effort made to measure the amount of priming water. In the present day we do not have so much trouble from priming as in past times, when lower pressures were in use and the steam space was practically what it is now. Still, there are yet large quantities of unevaporated water often carried over to the engines by the rush of steam. It is obviously useless to exercise great care in measuring the feed if a considerable part of it is carried from the boiler to the condenser simply as water. In such a case the boiler is credited with a high evaporative efficiency by reason of its very fault; and the engine is debited with steam which it never receives, but on the contrary is having its action impaired by the presence of water in the cylinders. The method of testing for priming is as follows:—A quantity of steam from the main steam-pipe is condensed in a special surface-condensing apparatus, and collected, and at the same time a sample of water is taken separately from the boilers. Both of these samples are carefully analyzed to determine the quantity of salt present in each. As the whole of the salt found in the sample from the steam-pipe must have come over from the boiler in conjunction with priming water, and not with steam, a simple calculation will show how much boiler water corresponds with the quantity of salt, if any, found in the steam-pipe sample. From this it is easy to determine what percentage of the whole feed-water has passed from the boilers in the form of water, or, in other words, what percentage there is of priming. The chemical determination for salt is a very simple one, and is capable of being carried with ease to an exceptional degree of certainty. The observed and calculated data of the trial are given in a full table appended to the report. The mean boiler pressure was 105·8 lbs. above atmosphere, the vacuum 10·12 lbs. below atmosphere, the revolutions 36·82 per minute, the mean indicated horse-power 2977, the fuel per square foot of grate per hour 31·3 lbs., and the feed-water per indicated horse-power per hour 20·77 lbs., allowing for auxiliary engines. The efficiency of the boiler was 66·1 per cent., and of the engines 11·7 per cent. The combined efficiency of engine and boilers was 7·7 per cent.

A very interesting discussion followed the reading of the report, but a great part of this it would be useless to give, as many details of the trial have necessarily been omitted from our brief abstract.

A paper was next read "On Condensation in Steam-Engine Cylinders during admission." This was a contribution by Lieutenant-Colonel English, of Jarrow. In former papers on this subject the author had given experimental data, but it was objected that he had left out of account the range of temperature in the cylinder. In order to show that this was not the case, he submitted the following formulæ, which, he claimed, proved his case. The former papers, a study of which is necessary to a proper understanding of the facts, may be found in the Transactions of the Institution for the years 1887 and 1889.

In jacketed cylinders the weight of steam condensed per stroke and not re-evaporated at cut-off is represented by the expression

$$\frac{56}{\sqrt{\text{revs. per second}}} \times \frac{(S_c - S_1)}{L}\rho_1,$$

where S_c is the unjacketed clearance surface in square feet, S_1 the fresh surface exposed during admission up to cut-off, ρ_1 the initial density of the steam in pounds per cubic foot, and L the latent heat of evaporation in thermal units. If d be the diameter of the cylinder in feet, l the length of stroke in feet, m the proportion of stroke up to cut-off, $\mu = \frac{S_c}{2 \times \text{area of cylinder}}$, and N the number of revolutions per minute; then S_c = unjacketed clearance surface $= \frac{\mu\pi d^2}{2}$; $S_1 = \pi dml$; $\sqrt{\text{revs. per second}} = \frac{\sqrt{N}}{7{\cdot}75}$; and the foregoing expression may be written

$$\text{Weight condensed} = \frac{56 \times 7{\cdot}75}{L \times \sqrt{N}}\left(\frac{\mu\pi d^3}{2} - \pi dml\right)\rho_1$$

$$= \frac{868}{L \times \sqrt{N}}\left(\frac{\mu}{ml} - \frac{2}{d}\right)\frac{\pi d^2 ml}{4}\rho_1.$$

But $\frac{\pi d^2 ml}{4}\rho_1$ is the weight of steam per stroke uncondensed at cut-off, and 868 may be taken as an approximate value for L; therefore for jacketed cylinders;

$$y = \frac{\text{weight condensed}}{\text{weight uncondensed}} = \frac{1}{\sqrt{N}}\left(\frac{\mu}{ml} - \frac{2}{d}\right).$$

For unjacketed cylinders a similar approximate expression is

$$y = \frac{1{\cdot}5}{\sqrt{N}}\left(\frac{\mu}{ml} - \frac{2}{d}\right).$$

The author supported his views by means of a voluminous table, in which he gathered together the observed data on a number of steam-engine trials made by various well-known authorities, to which he attached the results obtained by calculation on his system.

A short discussion followed the reading of this paper, and the meeting was then brought to a conclusion by the usual votes of thanks.

The summer meeting of the Institution will be held at Portsmouth, on July 26 to 29.

THE ROYAL SOCIETY SOIRÉE.

THE annual *soirée* of the Royal Society, which took place on Wednesday, May 4, may be said to have been the most successful that has been held for many years. All the necessary arrangements, which were by no means few in number, were carried out without a hitch, while the exhibits were of a most attractive nature. As regards the latter, the following are a few notes of the most novel and important objects displayed:—

Prof. T. E. Thorpe exhibited a model to illustrate the general phenomena of explosions as brought about by the presence of dust particles, in explanation of the causes of colliery explosions. This apparatus consisted of two long narrow boxes, fitted together in the form of a cross. On the bottom of these boxes was thinly strewn a quantity of fine Lycopodium powder, while at one end of the longer box there was a small chamber in which a blank cartridge was fired. The firing of this cartridge corresponded to the direct action of a "blow-out shot," while the dust raised by the concussion, which carried the flame throughout the entire apparatus, took the place of the fine coal dust. The apparatus also showed that the progress of such an explosion was always accompanied with increase of violence.

Prof. Clowes showed an ordinary miner's safety-lamp which had, by a very simple contrivance, been converted into a delicate instrument for detecting minute proportions of fire-damp. To the ordinary burner an additional tube is made to pass through the oil reservoir, one end of it being connected, by means of a flexible tube, with a small portable bottle of compressed hydrogen. The hydrogen when turned on becomes ignited close to the oil burner, the flame of which is extinguished by turning down the wick; by adjusting the flame of hydrogen to the standard height, a luminous column of light is seen vertically over it, from the behaviour of which the amount of inflammable gas can be directly estimated. At the conclusion of the experiment the wick is simply turned up, and ignited from the hydrogen flame; the latter is then disconnected from the bottle. From 0·25 to 3 per cent. of fire-damp has in this way been estimated, while greater quantities than these have been measured by reducing the size of the flame.

Vacuum tubes without electrodes, exhibited by Dr. Bottomley. These tubes, which were of a variety of shapes and kinds, illustrated very beautifully all the phenomena of stratification. They were sensitive also to magnetic and electro-dynamic influence, and showed the phenomena of molecular bombardment. The brilliant illumination of a piece of Iceland spar contained in a glass sphere afforded an excellent means of displaying the electrical excitements. [For an account of experiments with vacuum tubes, see a letter by Mr. Bottomley in NATURE, January 6, 1881, vol. xxiii. p. 218.]

Mr. Cecil Carus-Wilson exhibited some natural and artificial sands, from which he was able to produce many musical notes. These notes, as he explained, were the results of the rubbing together of the surfaces of the grains of sand, but he had met with several sands from which he could not obtain a vestige of a note. One special artificial sand sang only when rubbed in some sort of vessel.

Apparatus for measuring degrees of incompleteness of colour vision, exhibited by Mr. Brudenell Carter. The object used for the tests is a group of various colours, which were such that they could be seen by either reflected or transmitted light. The amount of illumination that was required to recognize the colours distinctly was a measure of the "degree of incompleteness." In order to control this amount of illumination, light of known intensity had to pass through a variable aperture before it fell on the test object, the size of this aperture being read off in square millimetres.

Captain Weir's azimuth diagram was exhibited by Mr. J. D. Potter. It is claimed for this diagram that besides being most ingenious, it furnishes one of the most successful modes of graphic solution of a mathematical problem that has ever been invented. It is used for finding the true azimuth of a heavenly body, taking into account the ever-changing errors of the compass, which in our days of iron ships have to be so carefully watched and recorded. The errors as usually determined are obtained from observations made of the compass-bearing of a heavenly body (the sun generally being taken) with its true bearing, and it is for the simplification of this method that this azimuth diagram has been found to be practically useful.

Prof. Oliver Lodge had three exhibits. The first was the projection of interference bands on a screen, being produced by a modified method of Michelson. Very striking also were the electric sparks in and to water, illustrating lightning effects and multiple flashes. In a shower, with too great spark-length for a strong discharge, a multitude of violet streams or spurts filled the air, resembling somewhat lightning flashes. The spark to water spread itself out over the surface, showing that the surface layer was a feeble dielectric, while the spark under water was brief but very violent, treating the water as a dielectric, and producing concussion. The electric retina, illustrating the possible meaning of the rod-and-cone structure, was very interesting; radiation from spheres which were in a suddenly disturbed and oscillatory electrical condition falling upon a graduated series of end-on cylinders, which responded by vibrating transversely.

Mr. W. Crookes repeated many of those beautiful experiments of electric currents of high potential and extreme frequency that were first carried out by Tesla. The discharges from a battery of Leyden jars were sent through the primary wire of an oil induction coil. The frequence of alternation amounted to no less than 1,000,000 a second, while the electromotive force reached the enormous amount of 100,000 volts. Perhaps it was as well that this frequency was great, otherwise the physiological action might have been rather surprising to those who trusted implicitly in Mr. Crookes. The resistance offered by the sheet of vulcanite to the strong current produced some fine flashes, while very pretty were the examples of brush discharges, St. Elmo's fires, &c., at the secondary poles of the oil induction coil.

The electrical apparatus shown by Captain Holden, R.A., consisted of some very important new instruments, among which we may mention the high-speed chronographic pen for taking a number of successive records of short intervals of time, the pen being automatically reset after each record; an improved simple compensated voltmeter on the hot wire system, and the dead-beat alternating current ammeter worked by a heated metal strip and free from self-induction.

Prof. Roberts-Austen exhibited a new electrical method for the exact determination of very high temperatures, which has rendered possible the construction of a very simple instrument, devised by Prof. H. Le Chatelier, that can be placed in the hands of any workman. The latter depends on the comparison of the intensity of the radiation emitted by a glowing body (the temperature of which has to be determined) with that of a standard source of light. To use the instrument it is pointed in such a direction as to have the light from the heated mass of metal in its field of view, so that the colour can be distinctly observed; in the same field of view a series of standard colours can also be made apparent (situated side by side with the heated metal), by turning a milled head screw which carries a pointer over a graduated scale. By matching the colours a direct reading of the position of the pointer gives the required temperature.

The Rev. F. J. Smith exhibited an electric tram chronograph which he had devised for measuring small periods of time, varying from one-fourth to one-twenty-thousanth part of a second. This instrument consists of a metal girder furnished with a T-shaped end, carries two steel rails, and is supported on a V-groove, hole, and plane system. The carriage, on which is fixed a slightly smoked glass plate, runs on these rails, driven either by a weight or by a coiled spring. A metal pillar, carried on a V-groove, hole, and plane system, is placed in front of the moving surface, and supports electro-magnetic styli which can be brought into contact with the smoked surface; a tuning-fork also is so placed that the traces are found to be recorded on the smoked plate so as to afford a means of measuring the time intervals. The two motions of the pillar, of rotation and vertical translation, allow a large number of observations to be made on the same plate. There are also continuous contact-breakers, whereby, when a photographic plate is fixed in the carriage, spark photographs of moving objects may be obtained. This instrument has been applied to the measurement of the velocity of projectiles, and small periods of time in physiological research, and to the photography of insects and falling drops of liquids.

Perhaps the most unique exhibit of the evening was the series of photographs of flying-bullets which Mr. Boys had obtained by a modification of an old method. The photographs showed beautifully the waves in the air caused by the rapid flight of the bullet analogous to those produced by a fast-going steamer. In one slide the small pieces of paper through which the bullet had passed were also seen ploughing their way through the air, producing quite as definite waves as the projectile itself, only of not such large dimensions. The passage of a bullet through a piece of wire was also very curious, the piece of wire that was cut off not having time to fall before it was seized by the lightning eye of the camera. The photograph showing a magazine rifle bullet piercing a glass plate brought out some very interesting facts. The glass appeared to be thoroughly scattered in a direction opposite to that in which the bullet was proceeding, the greatest scattering taking place on the side which the projectile touched first. The waves set up on the glass plate gave measures of the wave, length of the tremor caused, and the velocity of travel. The bullets used for these pictures were of various kinds, and the velocities varied from 750 to as much as 3000 feet per second, the former from a pistol and the latter from a magazine rifle, the bullet being composed of aluminium to obtain this great velocity.

The Committee of the Kew Observatory exhibited a testing camera for photographic objectives that had been designed by Major L. Darwin. With this instrument all the most important features of a lens can be accurately and swiftly determined. We may mention here that arrangements are being made that any lens sent to them will be thoroughly examined in all respects under the superintendence of Mr. G. M. Whipple, certificates of examination being made out, as is at present done in the case of other instruments.

We must now pass on to the photographs.

Astronomy was well to the fore with the exhibits of Messrs. Lockyer and Roberts. The former showed a fine spectrum of Nova Aurigæ, that had been enlarged twenty-five times from a negative taken with only a 6-inch object-glass and prism by the Brothers Henry and Hilger respectively; several fine photographs of stellar spectra illustrating the main evolutionary types according to the meteoritic hypothesis, and photographs of the 3-foot reflector at Kensington that is now near completion. Mr. Roberts showed some photographs of celestial objects; the original negative of Nova Cygni, taken with a 20-inch reflector with a two-hours' exposure, showing the Nova as a star of the thirteenth magnitude. An enlargement of the region in which Nova Aurigæ was situated when the star was of the fourth magnitude was also displayed, together with the original photograph taken with the instrument before mentioned, but with an exposure of three hours.

The photographs showing the great sun-spot of February last, exhibited by the Solar Physics Committee, may be said to be the best series that has ever been obtained. The series included nine days, and showed the remarkable changes that occurred during the interval from February 5 to February 17.

Mr. W. Saville-Kent exhibited a series of photographs, over a hundred, taken by himself, enlargements of the same, and water-colour sketches, illustrating coral reefs, coral animals, and the marine fauna generally of the Great Barrier district of Australia. A lantern exhibition illustrating the same subject was also included in the evening's programme. The reef views, which portrayed extensive areas of growing corals of innumerable varieties, were, as explained by the exhibitor, taken at abnormally low spring tides, and are as a matter of fact very rarely visible to the extent depicted. Among the more important points associated with this exhibit were the facts that in a large number of instances accurate measurements had been taken of the individual corals that composed the reefs photographed, such reefs being in easily accessible positions, where their subsequent amount and rate of growth could be periodically determined. This exhibit, more particularly with relation to the illustrations of living coral polyps—those of the mushroom corals, genus *Fungia*, being particularly noteworthy—represented the first occasion in which photography has been systematically applied to this highly interesting biological subject. A second novelty exhibited by Mr. Saville-Kent was a pearl of fine quality and considerable size that the exhibitor had caused the mother-of-pearl shell animal, *Meleagrina margaritifera*, to produce by means of a delicately-manipulated operation on the living animal.

From the Zimbabwe ruins, Mashonaland, some very valuable finds in the shape of pottery, gold crucibles, weapons, ingot moulds, &c., were exhibited by Mr. Theodore Bent and the Royal Geographical Society; while by the same exhibitors were shown a model of the circular temple at Zimbabwe, built of small blocks of granite without mortar; and several plans of ruins in Mashonaland. No less interesting also were the photographs of ancient Central American monuments and buildings from the ruins at Chichén Itzá (Yucatan), Palenque (Chiapas), &c., exhibited by Mr. Alfred P. Maudslay; and a selection from the proof-plates to the first memoir of the archæological survey of Egypt that is being undertaken by Mr. Percy E. Newberry. One of these proof-plates showed all the successive stages of a wrestling match between a black and a white man, more than a hundred different positions being recorded; the white man, we are sorry to say, seemed to be getting the worst of it in many of them.

Several important discoveries were made during the Royal Dublin Society's survey of the fishing grounds on the west coast of Ireland; specimens of several fish then obtained were exhibited by Prof. A. C. Haddon and Mr. E. W. L. Holt. Many new to British waters were found, while one quite new to science (*Nettophichthys retropinnatus*, Holt) was caught.

Some very curious worms composed Mr. F. E. Beddard's exhibit. They were specimens of *Branchiura Sowerbii*, and were found in a tank in the Regent's Park Botanical Gardens.

They possess a dorsal and ventral series of contractile gills, which make them differ from all other known fresh-water worms.

To summarize shortly a few of the other exhibits, we may mention Messrs. Pike and Harris's high tension apparatus; Mr. H. L. Callendar's platinum resistance pyrometers; the original specimen of *Asteropecten Orion* (Forbes), and a specimen of a slab of mountain limestone Bolland showing the passage of a foraminiferal ooze into crystalline calcite, by Prof. W. C. Williamson; Prof. Percy Frankland's crystals of active calcium glycerate (lævorotatory); and the two exhibits of turacin, one by Dr. C. A. MacMunn, showing the very remarkable spectrum it produces; the other by Prof. A. H. Church, who discovered this red pigment in the wing-feathers of certain plantain-eaters or Touracos. A very ingenious process of so-called colour photography was explained by Mr. F. Ives, of Philadelphia, who showed several pictures by means of a special optical lantern.

THE SOUTH LONDON ENTOMOLOGICAL AND NATURAL HISTORY SOCIETY.

THE annual Exhibition of this Society was held on the 5th and 6th inst., at "The Bridge House," London Bridge, S.E. The President, Mr. C. G. Barrett, F.E.S., in opening the Exhibition, gave a short account of the history of the Society from its formation by eleven South London entomologists in 1872; and he referred to the work done by members in rendering popular the study of biological science.

The exhibits were arranged in four rooms, and were very varied, including examples of nearly every order of the animal and vegetable kingdoms.

In the first room Mr. C. S. Cooper exhibited an almost perfect collection of British wild flowers and leaves; the Lambeth Field Club, Mollusca; Mr. J. T. Carrington, land shells from the Riviera, arranged so as to show variation; Mr. C. H. Collings and Mr. D. W. Collings, British and Australian birds' eggs and British birds; Mr. H. J. Turner and Mr. Rice, nests and eggs of British birds, the latter having a double nest of the great titmouse (*Parus major*). The tables around this room were set apart for the exhibition of objects by aid of the microscope, and among so many it is difficult to make a selection; but the more important objects were those of Mr. T. D. Ersser, who showed the circulation of the blood in a gold carp, a most interesting subject; Mr. J. H. Stanley, spawn of perch; Mr. H. Groves, the circulation of sap in Nitella; Mr. R. Macer, heads and eyes of various species of spider; Mr. West, freshwater Polyzoa; Mr. E. Hinton, preparations of the Hydroids, including the beautiful sea pen, killed with the tentacles fully extended; Mr. W. B. Medland, the pulsation in the heart of a snail; Mr. J. B. Medland, a section of the jaw of a mole, with the teeth *in situ* (polarized).

In the second room Mr. J. A. Cooper's birds' nests and eggs in natural clutches occupied one end, and were much admired: one of the principal features of this collection being that it is arranged to show the variation in different clutches of the eggs in one species. This was particularly noticeable in those of the red-backed shrike. Among the eggs there were white varieties of those of the chaffinch, lapwing, and great black-backed gull; variable series of the guillemot, razorbill, lapwing, and golden plover; also a series of nests containing eggs of the cuckoo, including nests of the wagtail, tree pipit, chaffinch, greenfinch, hedge sparrow, robin, flycatcher, yellow bunting.

In the class Insecta some of the more important exhibits were those of Mr. J. H. Leech, with sixteen drawers containing Palæarctic Lepidoptera. This collection attracted considerable attention. Mr. J. Jenner Weir showed exotic Rhopalocera, illustrating forms of mimicry, and fine examples of South African Ornithoptera. Mr. S. Edwards also contributed a large exhibit of exotic Rhopalocera. Adjoining these, was the Society's typical collection of Canadian Lepidoptera. Four drawers of European Neuroptera were shown by Mr. R. McLachlan. Mr. H. Moore exhibited a number of wasps' nests. Mr. T. R. Billup's exhibit comprised British Coleoptera, containing types of nearly all the known species; three drawers of Hemiptera-Heteroptera and one of Homoptera were beautifully arranged, and the adoption of a system of labelling giving the name of the species, the locality where taken, and date of capture, is much to be commended; seven drawers of Hymenoptera Aculeata, containing many rare species, also long series of Ichneumonidæ, many of the specimens being new to science, and others new to Britain; also two drawers of life-histories of Hymenopterous and Dipterous parasites, together with the larvæ and imagines of the Lepidopterous host. This last exhibit was one of the most interesting and instructive of the exhibition. Of British Lepidoptera there was a magnificent display, there being some forty exhibitors. Mr. R. South showed nearly the whole of his collection of *Pyrales*, *Crambi*, *Pterophori*, and *Tortrices*, a selection of *Noctuæ*, among which were extreme series of most of the polymorphic species in the group; a drawer of *Lycæna icarus*, showing the colour range of both sexes, one very blue female without black discoidal spots was especially interesting; a drawer of Geometræ showing that the colour and ornamentation of the female parent is transmitted to a large proportion of her offspring; Mr. C. G. Barrett, *Pieris napi*, one female of a light canary-yellow colour from Norfolk, others suffused with grey from South Wales, others with black spots and tips and dark nervures from the north of Ireland; varieties of *Anthocharis cardamines*; long series of *Odonestis potatoria*, showing extreme variation, the colour in the males ranging from chocolate to a pale buff; also extensive series of varieties of *Agrotis cursoria* and *A. tritici*, from the east coast of England. Mr. Barrett also exhibited a drawer of varieties of Rhopalocera lent to him for the purpose of figuring in his book on the British Lepidoptera, by the Rev. Joseph Greene, the Rev. O. Pickard Cambridge, Dr. Wheeler, Mr. J. E. Robson, Mr. E. Sabine, and Mr. Sydney Webb. It is doubtful whether such a collection of varieties has been seen before, and those Lepidopterists who pay special attention to the question of variation were much interested in the extraordinary varieties shown. Mr. F. Merrifield, examples of *Selenia illustraria*, *S. illunaria*, *S. lunaria*, *Eugonia alniaria*, *Vanessa urticæ*, *Platypteryx falcataria*, *Arctia caia*, *Bombyx quercus* and var. *callunæ*, bred by him in his experiments on the effect of temperature on the pupæ of certain species in causing variation. Labels were attached to each specimen showing the conditions to which the pupæ had been subjected, and the results obtained from these. It appeared that a lower temperature produced examples which were darker and more intense in colour than those subjected to higher temperatures. A third drawer of *S. illustraria* and *S. illunaria* was shown, as illustrations of the effect of temperature applied for a very few days to pupæ at a sensitive stage, *i.e.* just before they began to show the colour, the forcing temperature was about 77°; the natural temperature about 40° to 50°; a range of 15° or less (at a point which it appeared was not yet actually ascertained between 57° and 73°) was sufficient to produce the full temperature effects shown in the first two cases, but a range of much less than 13°, if at the right part of the thermometric scale, produced substantial difference of colouring. Mr. W. Farren contributed examples from Cambridge including fine yellow specimens of *Bryophila perla*, and extensive series of *B. muralis* and *B. impar* of Warren; these gave rise to considerable discussion among visitors as to whether *impar* was a true species or only a variety of *muralis*. Mr. R. S. Standen, a small box showing extreme varieties of *Argynnidæ*. Mr. Tugwell, a selection from his cabinet, including long series of *Eugonia alniaria*, Esp., melanic forms of *Phigalia pedaria*, *Boarmia repandata*, *Tephrosia biundularia*, &c., and striking varieties of *Abraxas grossulariata*. Mr. C. G. Gregson also put in a magnificent series of varieties of this last-named species, some of the specimens being entirely suffused with the black markings, in others the yellow-coloured markings were wanting, and many were very pale forms, the black markings being absent; Mr. Gregson also showed *Dianthœcia conspersa*, from various localities, to illustrate the local variation in that species—many of the forms were so extreme that he had given them varietal names. Mr. J. R. Wellman, his collection of Dianthœcia and Acidalia, also a drawer of *Cidaria russata*, bred and captured from various parts of Great Britain, a most interesting drawer as showing local variation. Mr. F. W. Hawes, Rhopalocera, reared in 1890 and 1891, chiefly from ova obtained by searching or from the captured female, thus enabling Mr. Hawes to ascertain the early life-histories of this group; among them were examples of *Hesperia lineola*, the species recently added to the British list by Mr. Hawes. Variation in *Arctia caia* was shown by Mr. Goldthwait, Mr. T. W. Hall, and Mr. A. Mera. Mr. C. H. Williams included in his series a gynandrous specimen of *Argynnis paphia* taken by him last summer in the New Forest, and much attention was paid to this beautiful specimen. Life-histories, the larvæ being mounted on the natural food-plant, were shown by Mr. J. A. Simes, Mr. A. Quail, and Mr. A. J. Croker, the latter gentleman's *Phorodesma smaragdaria* being especially noticeable. Mr. R. Adkin exhibited a collection of British Sphinges and Bombyces, arranged with a view to showing local variation, such variation being well defined in some of the species of the genus *Spilosoma.* Also a collection of Macro-Lepidoptera made at Rannoch, Perthshire, in 1891, illustrating an article on the local variation prevailing in that district recently contributed to the *Entomologist.* Mr. Tutt, extremely long and variable series of Noctuæ. Mr. Machin four drawers from his cabinet; among the rarer species were *Dicranura bicuspis* and *Drepana sicula.*

In the third room there was a large exhibit of marine Mollusca, by Mr. Conisbee. Mr. Step's exhibit of living Mollusca afforded a capital opportunity for comparing the mollusks as well as their shells. Between thirty and forty species were thus shown, each in a separate glass, and ranged from the substantial *Helix pomatia* to the graceful *Clausilia rugosa* among land snails; and from the large *Anodons* to the fragile *Planorbis linentus* among the aquatic species. Pond life was shown by Mr. Perks; living newts, &c., by Mr. R. Adkin, Jun.; and living snakes, &c., by Mr. Gee. A gigantic sponge was exhibited by Mr. Kedgley.

In a fourth room Mr. Reeves exhibited and explained an original set of diagrams, showing the correct positions of horses' legs while walking, trotting, and galloping, and to demonstrate their correctness the diagrams were transferred to a zoëtrope.

A large room was set apart for lectures, and during each evening crowded audiences listened to Mr. F. Enock, who lectured on "The Life-history of the British Trap-door Spider." The lecture was illustrated by Mr. Enock's original microphotographic slides, shown by means of the oxy-hydrogen lantern. Mr. E. Step's "Talk about Toadstools" was listened to attentively on each evening. The figures thrown on the screen were from Mr. Step's own photographs and drawings. A third lecture was given by Mr. George Day, illustrated by microphotographic slides, entitled "Domestic Friends and Foes."

IMÈRINA, THE CENTRAL PROVINCE OF MADAGASCAR.

ON Monday evening the Rev. James Sibree read a valuable paper on Imèrina, the central province of Madagascar, before the Royal Geographical Society. After an account of the work of recent explorers, of whom the French surveyors, MM. Catat and Maistre, and the English missionary, Mr. Baron, are the most important, Mr. Sibree came to the main subject of his paper, of which the following is an abstract.

M. Grandidier, who is now completing a splendid atlas of Madagascar, published a map of Imèrina on the scale of 1 : 200,000 in 1880, and in 1883 an orographical map coloured according to the contour lines. The road from the port of Tamatave to Antananarivo, the Hova capital, in the centre of the Imèrina province remains a mere footpath, impassable either to wheeled vehicles or to beasts of burden; and now, as 300 years ago, porters are the only means of transport.

Imèrina ("the elevated") is bounded on the east by the steep ridge of forest-girdled mountain sloping to the Indian Ocean. The other boundaries are indistinct, and the total area of the province may be estimated at 7000 square miles. The general level of the province is from 4000 to 4500 feet above the sea. It is a mountainous region, abounding in peaks, which rise high above the breezy plateau, and marked also by many valleys. The most prominent summits are Angàvokèly to the east, Ambòhimiangàra in the extreme west, Ihàranandriàna to the south, Milangàna, Ambòhimanòa, and Andrìngitra more central, and Ambòhipanìry and Vòhilèna to the north. The south-west of the province is dominated by the central mass of Ankàratra, a denuded volcano of great size, its peaks forming the culminating points of the island, and reaching nearly 9000 feet above the sea. The mountain-peaks are usually granite or gneiss, sometimes occurring in great rounded bosses, sometimes in fantastically carved pinnacles resembling from a distance Titanic forts, castles, and cathedrals. Decomposed granite covers a great part of the country with thick deposits of clay, sometimes white but more often tinted deep red by ferric oxide. Iron is abundant, gold has recently been discovered, graphite, galena, copper, and other useful minerals are also found in Imèrina. The watershed of the island lies much nearer the east coast than the west, and the two chief rivers rising in the extreme east traverse the breadth of the province on their way to the Mozambique Channel. The Ikòpa, fed by the Sisaony, the Andròmba, the Màmba, and other streams, flows north-westward through the fertile plain of Bètsimitàtatra, and farther north is joined by the Bètsibòka, under which name the united stream runs on to the sea at the Bay of Bembatòka. Lake Itàsy is the only large body of water in Imèrina, and probably owes its origin to volcanic subsidence.

On account of its altitude Imèrina has a pleasant temperate climate, although lying within the tropics. The south-east trade-winds, blowing fresh and moist over the forest belt and the wooded plains of the east, make the atmosphere peculiarly bracing in the cooler season. The annual rainfall at Antananarivo is about 53 inches. Through the clear pure air distant landscapes stand out with remarkable sharpness of outline. Towards sunset Imèrina is seen in its most attractive aspect; the hills, range beyond range, assume the richest shades of purple, the sky flames with crimson and gold, and the long clay walls of the native compounds glow like streaks of vermilion.

The general aspect of the province is bare, except for patches of primæval forest in the northern districts. Moor-like hills, which would look utterly dreary but for the marvellous atmospheric effects, predominate. Near Antananarivo the dried-up bed of an ancient lake, known as Bètsimitàtatra, forms a great plain, covered with rice-fields, which support a dense population. The steep sides of the river valleys are terraced, like great green staircases, with rice-plots, where the grain is sown broadcast, and whence the young plants are transplanted in the larger fields along the river-plains and in the meadows left by dried-up lakes.

The political subdivisions of Imèrina are mainly tribal, and are used for purposes of taxation, and for the apportionment of military levies and forced labour. No census has been taken, but an estimate based on the number of villages and houses justifies the estimate of the population at about 1,100,000. Except Antananarivo, there are only small villages in the province, but these are clustered very closely together, especially to the north and north-west of the capital. Several of these were formerly tribal capitals, and Ambòhimànga still retains nominal equality with Antananarivo in royal speeches. The old villages were always built on hills for purposes of defence, and surrounded by double or treble lines of fosses and embankments dug out of the hard red clay. A narrow bridge of the red clay leads to the gateway, which is formed of blocks of rock, either a circular slab 10 or 12 feet in diameter, which was rolled between upright gate-posts so as to block the way, or massive upright monoliths bearing strong wooden gates. In recent times the Hovas have largely deserted these fortresses, and built themselves villages close to the rice-fields. Graves of the aboriginal Vazimba are scattered over the province, but local feeling prevents any examination of these from being made.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, May 2.—M. d'Abbadie in the chair.—The movements of minute organisms analyzed by means of chronophotography, by M. Marey. Using an arrangement described in the *Revue Générale des Sciences* in November last, and in NATURE, vol. xlv. p. 228, M. Marey has obtained photographs of the movements of blood corpuscles in the capillaries, and has analyzed the movements of zoosphores in the cells of a Cladophora. Enlargements from these negatives have been presented to the Academy. By taking a series of pictures at intervals of about one-tenth of a second, and projecting them upon a screen at about the same rate, the effect of the real motions of the object can be reproduced. The arrangement for doing this will be described in a future communication.—Observations of Swift's, Denning's, and Winnecke's comets, made at Algiers Observatory with the *coudé* equatorial, by MM. Rambaud and Sy. Observations of position are given.—On the approximation of functions of very large numbers, by M. Maurice Hamy.—On the tautochronism in a material system, by M. Paul Appell.—On the laws of electrolysis, by M. A. Chassy. When a substance having the formula M_pR_q is electrolyzed, M designating an electro-positive and R an electro-negative radicle, one equivalent of the radicle R, and $\frac{p}{q}$ equivalents of the radicle M are disengaged when one equivalent of hydrogen is set free in a voltameter included in the circuit. Wiedemann and others have found exceptions to this law, for in the case of some salts, $\frac{q}{p}$ equivalent of the radicle R and one equivalent of the other radicle are disengaged. M. Chassy proposes to substitute the following law for those previously enunciated, all cases being included in it: "Lorsqu'on électrolyse une substance quelconque il se dégage toujours l'équivalent d'hydrogène ou la quantité correspondante du radical électropositif."—A new case of abnormal solution: saturated solutions, by M. F. Parmentier. The author finds that the solubility of ethyl bromide in ether decreases rapidly with increase of temperature.—The occurrence of fluorine in different varieties of natural phosphates, by M. Ad. Carnot. From the results of the analyses of a number of sedimentary phosphates it is concluded that in the sedimentary phosphates the proportion of fluorine is sensibly equal to that in apatites having an equal percentage of phosphorus. Phosphorites of fibrous, semi-crystalline structure have almost the same composition as crystallized apatites. Earthy or compact phosphorites contain a less proportion of fluorine. Concretionary, zoned, and mammillated phosphorites contain barely any fluorine.—Estimation of small quantities of carbon monoxide by means of cuprous chloride, by M. L. de Saint-Martin.—Thermal study of the value of the replacement of hydrogen in phenolic hydroxyl, by M. de Forcrand. C_6H_6O sol. + Na sol. = $C_6H_5 . ONa$ sol. + H gas . . . . + 39·10 cal. This is practically the mean value for the replacement of H by Na in tertiary alcohols and acids, for $\frac{27·89 + 50·17}{2} = + 39·03$.—On an ethylnitroketone and an acetylnitroketone derived from camphosulphophenols, by M. P. Cazeneuve.—Determination of the surface of ebullition of normal paraffins, by M. G. Hinrichs.—Action of pyridine bases on certain sulphites, by M. G. Denigès. Compounds of the type SO_3M'', C_5H_5N have been obtained and examined.—Preparation and physical properties of acetyl fluoride, by M. Maurice Meslans. (See Notes).—Diamidophenyl sulphone and some of its derivatives, by M. Ch. Lauth.—Colouring matters and azo and alkyl compounds derived from chrysaniline, by MM. A. Trillat and De Raczkowski.—On a soluble naphthol derivative, by M. Stackler.—Remarks on some fishes from Upper Tonkin, by M. Léon Vaillant.—On *Cerataspis petiti*, Guérin, and on the systematic position of the species *Cerataspis*, Gray (*Cryptopus*, Latreille), by MM. A. Giard and J. Bonnier.—On an embryological law for the orders *Rhabdocœlida* and *Triclada*, by M. Paul Hallez.—On the circulation of the blood in young spiders, by M. Marcel Causard.—On the discovery of *Bactryllium* in Meurthe-et-Moselle Trias, by MM. Bleicher and P. Fliche.—Applications to normal physiology and pathology of the temporary loss of the activity of tissues by local cocainisation, by M. C. A. François-Franck.—Observation of a meteor, by M. L. Simon (extract from a letter to M. Wolf). The meteor was observed on April 24, at 11h. 55m. in the evening. It moved from east to west at an altitude of about 70° or 80°.

DIARY OF SOCIETIES.

London.

THURSDAY, May 12.

Royal Society, at 4.30.—Transformers: Prof. Perry, F.R.S.—On the Probable Effect of the Limitation of the Number of Ordinary Fellows elected into the Royal Society, to Fifteen in each Year, on the Eventual Total Number of Fellows: General Strachey, F.R.S.—On the Shoulder-girdle in Ichthyosauria and Sauropterygia: J. W. Hulke, F.R.S.—On the Embryology of Augiopteris evecta (Hoffm.): J. B. Farmer.—Note on Excretion in Sponges: G. Bidder.—On the Development of the Stigmata in Ascidians: W. Garstang.

Mathematical Society, at 8.—On an Operator that produces all the Co-variants and Invariants of any System of Quantics: Dr. W. E. Story.—Applications of a Theory of Permutations in Circular Procession to the Theory of Numbers: Major MacMahon, F.R.S.

Institution of Electrical Engineers, at 8.—Notes on the Light of the Electric Arc: A. P. Trotter. (Discussion.)—On the Cause of the Changes of Electromotive Force in Secondary Batteries: Dr. J. H. Gladstone, F.R.S., and W. Hibbert.

Institution of Civil Engineers.—Students' Visits to the Beckton Gas Works, the Northern Outfall Sewer, the Victoria and Albert Docks, and the P. and O. s.s. *Oceana*. Leave Fenchurch Street at 9.18 a.m.

Royal Institution, at 3.—The Chemistry of Gases: Prof. Dewar, F.R.S.

FRIDAY, May 13.

Royal Astronomical Society, at 8.

Physical Society, at 5.—An Instrument for Drawing Parabolas: R. Inwards.—Some Electrical Instruments: F. H. Nalder.—An Instrument for Measuring Magnetic Fields: E. Edser and H. Stansfield.

Institution of Civil Engineers.—Students' Visits to Woolwich Arsenal, the Works of the London Electric Supply Corporation at Deptford, and the Tower Bridge. Leave Charing Cross at 9.40 a.m.——At 7.30.—Students' Annual Dinner at the Holborn Restaurant.

Royal Institution, at 9.—The New Star in Auriga: Dr. William Huggins, F.R.S.

Amateur Scientific Society, at 7.—Exhibition of Objects of interest.——At 8.—Recent Additions to Botanical Science: L. A. Boodle.—The Copper Production of North America: W. Semmons.

SATURDAY, May 14.

Royal Botanic Society, at 3.45.

Royal Institution, at 3.—J. S. Bach's Chamber Music (with many Musical Illustrations): E. Dannreuther.

MONDAY, May 16.

Victoria Institute, at 8.—On Primitive Man: Sir W. Dawson and Rev. J. Meilo.

TUESDAY, May 17.

Zoological Society, at 8.30.—On the Geographical Distribution of the Land-Mollusca of the Philippine Islands: Rev. A. H. Cooke.—Resultats des Recherches Ornithologiques faites au Pérou par M. Jean Kalinowski: Graf Hans von Berlepsch, C.M.Z.S., and M. Jean Stolzmann.—On Lucioperca marina: G. A. Boulenger.—On the Antelopes of the Genus Cephalophus: Oldfield Thomas.

Institution of Civil Engineers, at 8.—The Distribution and Measurement of Illumination: A. P. Trotter. (Discussion.)—The Measurement of High Temperatures: Prof. W. C. Roberts-Austen, F.R.S.

Royal Institution, at 3.—Photography in the Colours of Nature; Frederick E. Ives.

WEDNESDAY, May 18.

Royal Meteorological Society, at 7.—Results of a Comparison of Richard Anémo-Cinémographe with the Standard Beckley Anemograph at the Kew Observatory: G. M. Whipple.—Rain-drops: E. J. Lowe, F.R.S.—Levels of the River Vaal at Kimberley, South Africa, with Remarks on the Rainfall of the Watershed: W. B. Tripp.

Royal Microscopical Society, at 8.—On the Organs of Oviposition in certain Cattle Ticks: R. T. Lewis.—The Penetrating Power of the Microscope: E. M. Nelson.—The Rings and Brushes of Crystals: E. M. Nelson.

THURSDAY, May 19.

Royal Society, at 4.30.

Chemical Society, at 8.—Magnetic Rotation of some Acetyl Derivatives: W. H. Perkin, F.R.S.—Studies on Isomeric Changes, No. IV.; Halogen Derivatives of Quinone, Part I.: A. R. Ling.—Note on Diastatic Action: E. R. Moritz and T. A. Glendinning.—Formation of the Hydrocarbon $C_{18}H_{12}$ from Phenylpropionic Acid: Dr. Kipping.

Institution of Electrical Engineers, at 8.

Royal Institution, at 3.—The Chemistry of Gases: Prof. Dewar, F.R.S.

FRIDAY, May 20.

Royal Institution, at 9.—Electro-Metallurgy: J. Wilson Swan.

SATURDAY, May 21.

Royal Institution, at 3.—J. S. Bach's Chamber Music (with many Musical Illustrations): E. Dannreuther.

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THURSDAY, MAY 19, 1892.

THE TELL EL-AMARNA TABLETS IN THE BRITISH MUSEUM.

The Tell el-Amarna Tablets in the British Museum, with Autotype Facsimiles. (London: Printed by order of the Trustees, 1892.)

DURING the summer of 1887, a woman belonging to the household of one of the "antica" dealers who live at or near Tell el-Amarna, in Upper Egypt, set out to follow her usual avocation of digging in the sand and loose earth at the foot of the hills for small antiquities. Every man, woman, and child in the neighbourhood spent, and probably still spends, a large portion of each day in this profitable pursuit, for in the winter season they were able to sell at good prices the scarabs, rings, fragments of beautifully glazed Egyptian porcelain, and other objects of this nature, of which there seemed to be an endless supply in the ground round about. From the time when Wilkinson made his first journey to this place, until quite recently, every traveller who has visited the spot has been able to bring away with him interesting and important antiquities, which have either revealed new facts in Egyptian history, or have served to illustrate and explain processes in the technical arts known to the Egyptians. In the early years of this century, when the scientific staff attached to Napoleon's expedition to Egypt was compiling the materials for the splendid map of Egypt afterwards edited by Jacotin, it was noticed that the "ruins of a large town" existed at Tell el-Amarna, and it is said that a superficial search made over this part of the country resulted in the finding of a number of fine objects which have since filtered into several European collections of Egyptian antiquities. But whatever things have been dug out from these ruins, or from the ground round about them, or however great their importance, nothing possessing the historical and scientific value of the antiquities discovered by the Tell el-Amarna woman in 1888 hath ever rewarded searcher before. The exact details of her search will never be known, neither can the exact spot where she made her great discovery be identified (for the Arabs took care to obliterate all traces of the diggings made by them on the spot after her "find"), but it is certain that in a small chamber at no great depth below the surface, she found a number of clay tablets the like of which had never been before dug up in Egypt. The number of these tablets and fragments is variously given, but it seems that the outside limit may be set at three hundred and thirty; in this matter, however, and indeed in making any statement which is based upon the word of many sellers of "anticas" in Egypt, the writer (and the reader) must protect himself by saying after the manner of the pious Muhammedan, "But God knoweth." Of this "find" the Trustees of the British Museum secured eighty-two tablets, the Gîzeh Museum in Egypt about sixty, and the Berlin Museum about one hundred and sixty pieces, of which a large number are fragments which give no connected sense. The authorities of this last institution published the texts from their own collection together with those from the tablets at Gîzeh by lithography under the editorship of Drs. Abel and Winckler, but the results already gleaned by scholars from this edition appear to be meagre when compared with the quantity of material which the originals offer for study.

The Tell el-Amarna tablets are different from all other known cuneiform documents. They lack the symmetrical form of the tablets from the libraries of the old Babylonian temples, or of those from the library at Kouyunjik, founded by the mighty kings of the last Assyrian Empire—Sargon, Sennacherib, Esarhaddon, and Assurbanipal; the material is, in many cases, ill-kneaded, and contains fragments of flint or other coarse materials; the colour of the clay varies from a light to a dark dusk tint, and from a flesh colour to dark brick-red. They are written in a hand which, to some extent, resembles the Neo-Babylonian writing used commonly in Babylonia and Assyria for about seven centuries before Christ. It possesses, however, characteristics different from those of any other style of cuneiform writing of any period now known to exist, and nearly every tablet contains forms of characters which have hitherto been thought peculiar to the Ninevite or Assyrian style of writing. The large, bold hand found upon some of the tablets suggests the work of the unskilled scribe, but more careful examination shows that it is the result of unconventionality rather than ignorance. The details of the peculiarities of spelling need not be discussed here, but the expert will find many rare and important examples of Assyrian orthography never dreamt of before. The Semitic dialect in which the tablets are written is very closely related to the Hebrew of the Old Testament, and the "Canaanite" forms of pronouns, &c., are of peculiar interest for the student of the Bible, for many of them are new, and they afford the means of explaining certain difficulties which now exist in Semitic grammar. Although these tablets offer a satisfactory solution of some difficulties, they raise many questions which will probably remain unanswered for some time, and among these there is one, not the least important, of how it happens that a governor of Egypt, who was a vassal, and ruling in Syria, should bear the name of Itagamapairi, which is neither Semitic nor Egyptian?

The Tell el-Amarna tablets are unique as an archæological "find," and they are also unique as a means of weaving together the threads of the histories of two or three of the greatest nations of antiquity at a critical period. As we are able to say, with comparative certainty, that they were all written between the years 1500–1450 B.C., they have an authority possessed by few of the documents coming down from this remote period. They partly fill, moreover, a gap in the history of the dynasties of Mesopotamia and Syria, for although much comparatively is known concerning the period in which the Assyrian Empire was founded—about B.C. 1800—and although we have annals of many kings between B.C. 1320 and 620, the history of the period between B.C. 1800 and 1320 is almost unknown.

The Tell el-Amarna tablets in the British Museum consist of a series of despatches written from kings of Babylonia, Alashiya, Mitani, Phœnicia, Syria, and Palestine to Amenophis III., and to his son, Amenophis IV., frequently named Khut-en-aten, or Khu-en-aten, and the "heretic king"; among them also is the draft of a despatch from Amenophis III. to a king of Karaduniyash. Many of them are of a personal and private nature, and these are, of course, the most interesting, for they reveal details of the family life of the great kings of the East, which the ordinary inscriptions have failed to preserve for us; the remainder refer to State business, and show beyond all doubt how close was the connection between the kings of Babylonia, Mitani, and Karaduniyash and the kings of Egypt, and also how great was the commerce and intercourse between these countries. It will be remembered that the Egyptians gained their first foothold in Syria under Amasis I., who, about B.C. 1700, brought the war of independence to a successful close, and marched into Sharuhen, a city to the south of Gaza, mentioned in Joshua xix. 6. His successor, Amenophis I., made no further advance into Syria or Mesopotamia; but Thothmes I., about B.C. 1633, marched into Northern Syria, called Ruthen, and set up a tablet to mark the limit of the frontier of Egypt. His son made no attempt to "enlarge the borders" of Egypt in this direction, and the "wild woman" Hatshepset was too much occupied with fitting out her expedition to Punt to trouble about such things; but when Thothmes III. ascended the throne of Egypt, about B.C. 1600, he at once set out to crush the rebellion which had broken out all over the country to the north-east of Egypt. Making his way by the peninsula of Sinai, he passed into Syria, and within a month from the time he set out he defeated the rebels, whose head-quarters were at Megiddo, and captured the city. During the next few years he marched through the country round about, carrying off spoil, and establishing the worship of Amen-Rā and other Egyptian gods in the principal cities. At a city on the Euphrates called Ni, he set up a tablet near one set up by his grandfather several years before, and it is clear that his hold upon Western Mesopotamia was no shadowy power. Indeed his conquest of the city of Ninip, and the worship of the gods of Egypt established there by him, is referred to by the inhabitants of that place when they write to Amenophis III. more than one hundred years later. When Amenophis III. ascended the throne of Egypt about B.C. 1500, he was, thanks to the bloody victories of his predecessors, able to assume the sovereignty of Western Mesopotamia and Syria without much fighting, and it seems that his expeditions to these parts were undertaken as much for the sake of the lion hunts which he conducted there as for the purposes of conquest. He boasts on his scarabs that in the first ten years of his reign he slew 102 lions with his own hand. That the country of Mitani offered fine opportunities for sport we know from one inscription which says that Thothmes III. slew 120 elephants there; and Tiglath-Pileser I. (B.C. 1120) boasts in his annals that on foot he slew 120 lions with his own hand in Mitani (Rawlinson, "Cuneiform Inscriptions," i. pl. 16, 76–79). While on one of these semi-warlike expeditions he fell in love with a fair-haired, blue-eyed, graceful girl named Thi, the daughter of parents whose names were Iuaa and Thuaa, and she was brought to Egypt in the tenth year of the king's reign, accompanied by another wife of Amenophis, and 317 of her ladies. Thi was evidently the Egyptian monarch's favourite wife; she became *par excellence* the "Queen of Egypt," and her son Amenophis IV. became King of Egypt. Amenophis III. also married a sister and daughter of Kallimma-Sin, King of Karaduniyash, and made proposals for another of his daughters, named Sukharti, while she was still a child, and he took to wife also the sister and daughter of Tushratta, the King of Mitani. A letter from Burraburiyash also reveals the hitherto unknown fact that his son married a daughter of the King of Egypt. One of the most interesting of these tablets is the draft of a letter from Amenophis III. to Kallimma-Sin, King of Karaduniyash, a country conterminous with Assyria; it is the only known letter of Amenophis in Babylonian, and is written upon a tablet of Nile mud. The subject of the letter is a proposal for the hand of Sukharti, whose father, Kallimma-Sin, writes back to Egypt asking what has become of his sister who married the King of Egypt many years before? In reply to this Amenophis invited Kallimma-Sin to send messengers to see and to converse with the lady, and to carry back news of her to her brother. An embassy was sent to Egypt, but its members were too young to be able to remember what the lady had been like, and they failed to identify her satisfactorily. Kallimma-Sin is not unwilling to discuss the marriage of his younger daughter Sukharti, but he points out that he usually gives his daughters to the "kings of Karaduniyash," who make handsome presents to himself and his messengers. Not to be defeated in his desire by the paltry question of gifts to the wife's relatives, Amenophis says that he is not only willing to give for Sukharti as much as all the other suitors could or would give put together, but he will send a gift to Kallimma-Sin in honour of this king's sister, who is now living with him in Egypt. This point satisfactorily settled, Amenophis proceeds to discuss the proposal of Kallimma-Sin for an Egyptian princess, and he plainly but forcibly tells him that "the daughter of the king of the land of Egypt hath never been given to a 'nobody.'" Kallimma-Sin replies, "Why not? Thou art king, and canst act as thou pleasest"; but, willing to be satisfied with a lady of less rank than a princess, he adds, "Surely there be daughters of nobles who are beautiful women in Egypt. Now, if thou knowest a beautiful lady, I beseech thee to send her unto me; for who here could say that she is not a princess?" What Amenophis finally arranged for "his brother Kallimma-Sin" we know not, but it seems that he gave him a large quantity of gold, and that he married Sukharti after all. The letters of Burraburiyash to Amenophis III. are scarcely less interesting, for they refer to old intrigues of the Canaanites, to commercial treaties, and they give some account of this king's gifts to the daughter of Amenophis who was about to marry his son.

The most important correspondent of Amenophis in the land of Mitani was Tushratta, whose sister and daughter he married, and who writes to his son-in-law with a mixture of affection and avarice amusing to contemplate. For example, having acknowledged the receipt of a letter from Amenophis, and said that its "contents pleased him so greatly that even if it were possible to dissolve all the friendship which had existed between them in times gone by, the words of this message alone would, for himself, suffice to re-establish their friendship for ever," he next begs him to send him much gold, and artfully refers to a gold libation bowl and vessels profusely decorated with gold ornaments which Amenophis had sent to his father, thereby hinting that similar gifts would be most acceptable to himself. In true Oriental fashion he says, "When my brother has sent the gold, if I ask, 'Is it enough?' the answer may be, 'Fully enough'; or I may ask, 'Is it the full amount?' and the answer may be, 'It is more than the full amount.'" In the latter case Tushratta declares that he will be "very glad"! In another letter Tushratta gives an account of his accession to the throne. It appears that when his father Shutarna died, his brother Artashumara became king, but was shortly after slain by rebels. Though quite young, Tushratta rallied his friends and supporters, and after some trouble succeeded in slaying his brother's murderers. Facts of this nature are of great importance for restoring the history of this long-forgotten country. It is an interesting fact that together with such letters there always arrived gifts, which consisted of horses, chariots, gold vessels, ornaments made of gold and lapis-lazuli, eunuchs and ladies for the king's household; and the relatives of the Mesopotamian princesses who had become wives of the King of Egypt never forgot to send them gifts of earrings of gold, choice oil for anointing, &c. Sad to relate, however, some of the writers of these letters complain that Amenophis did not send them gifts in return. In a third letter Tushratta mentions that the goddess "Ishtar of Nineveh, lady of the world," had gone down into Egypt during his own reign and during that of his father, and he begs Amenophis to increase the worship of this goddess in Egypt tenfold. A fourth letter of Tushratta is sent to the "Queen of Egypt," who can be none other than the blue-eyed, fair-haired Thi.

Passing from the letters which refer to Amenophis's marriages contracted with Mesopotamian princesses, we come to those relating to the matter-of-fact business of the Egyptian Government of that day. These consist of reports of disasters to the Egyptian power and of successful intrigues against it, coupled with urgent entreaties for help, pointing to a condition of distraction and weakness in Egypt and her dependencies. Some of them must have been addressed to Amenophis III. towards the close of his long reign of about thirty-six years, but the greater number clearly belong to the reign of his son Amenophis IV., for the disorganized condition of the Egyptian provinces in Phœnicia and Syria which they reflect could only have come into existence when Egypt herself was torn by the rival factions which sprang up when that king endeavoured to substitute the worship of the Disk for that of Amen, the mighty god of Thebes. The chief cities of Phœnicia, Tyre, Sidon, Byblos, Aradus, and Simyra (which commanded the road to Aradus), representing the Egyptian power, were being daily attacked by the ever-increasing forces of the enemy, who, seeing the impotence or supineness of Egypt, grew bolder and bolder. Nor did the brave and loyal defence of such men as Rib-Adda, governor of Byblos, and Abi-Milki, King of Tyre, stave off for long the overthrow of the Egyptian power in Phœnicia. The desperate position of this latter loyal officer is almost pathetic in its hopelessness. In one letter to the King of Egypt he says, "My lord, my sun, my god, seven times and seven times do I prostrate myself at the feet of the king, my lord. I am the dust beneath the feet of the king, my lord, and that upon which he treadeth. O my king and lord, thou art like unto the god Shamash and to the god Rimmon in heaven. Let the king give counsel to his servant. Now the king, my lord, hath appointed me the guardian of the city of Tyre, the 'royal handmaid,' and I sent a report in a tablet unto the king, my lord; but I have received no answer thereunto." He then announces the delivering of the city of Simyra into the hands of Aziru the rebel, by Zimrida, governor of Sidon, who had also captured the city of Sazu, wherefrom Abi-Milki drew his supplies of wood and water, for neither existed naturally on [the bleak rock of Tyre; in consequence many Tyrians died of want. Moreover, Zimrida, Aziru, and the people of Aradus attacked the forces of Abi-Milki in chariots by land and in ships by sea. In conclusion he sadly adds, "I am surrounded on all sides with foes, and I have neither wood to warm myself, nor water to drink; I send this tablet to the king by the hands of a common soldier, and may the king send me an answer speedily." When his condition becomes more desperate he sends another despatch, and with it a gift of five talents of copper, hoping thereby to extort an answer from the king of Egypt; in this he reports events with a Cæsar-like brevity thus:—"The king of the land of Danuna is dead, and his brother has succeeded him; there is peace in his land. One half of the city of Ugarit has been destroyed by fire. The soldiers of Khatti have departed Itagamapairi of Kadesh and Aziru have rebelled, and are fighting against Namyawiza. Zimrida, governor of Sidon and Lachish, is gathering together ships and men."

A letter of considerable importance is that of Akizzi, governor of Katna (Çana), for it refers to the origin of the worship of the sun in Egypt. It appears that the King of Khatti came to Katna, and carried off the image of the Sun-god, and Akizzi writes to Amenophis III., asking for money to ransom the image; he makes his appeal on the ground that Shamash the Sun-god, the god of his fathers, became also the god of the ancestors of Amenophis, and that they called themselves after his name. Now this clearly has reference to the title "son of the Sun," which was adopted by nearly every king of Egypt, and indicates that Akizzi believed that the worship of the sun was introduced into Egypt from Asia.

Space forbids our quoting more from these interesting documents, but sufficient has been said above to show what an important contribution to our knowledge of Oriental diplomacy about 1500 B.C. the Tell el-Amarna tablets offer. Incidentally they reveal many new facts of history; they offer a new field for the researches of the geographical student, and the identification of many towns and countries mentioned in the Bible and in the Egyptian inscriptions has already been obtained; they give us for the first time the names of Artatama, Artashumara, and Tushratta, kings of Mitani, and of Kallimma-Sin, king of Karaduniyash; they supply the reasons why and show how the Semites came to have such power in Egypt; and depict the inevitable anarchy which prevails in dependencies or colonies when the dominant power totters or declines.

We have already said that the Tell el-Amarna tablets are different from any other cuneiform documents known, and it is precisely this difference which has made their publication a difficulty. To make a satisfactory edition of these texts it was necessary to unite the skill of the Assyriologist with the accuracy of the photographer, for the former could only transcribe the characters more or less accurately, being powerless to give their exact shape and form, and the latter, while reproducing their exact shape and form, could only show the characters on the flat-sided tablets, those on the rounded edges remaining invisible. The Trustees of the British Museum, then, decided to print in cuneiform type a full transcript of the texts in characters as closely resembling the originals as possible, and in addition to give a number of characteristic specimens reproduced by the autotype process, so that the student who is unable to visit the Museum may be able to make himself thoroughly acquainted with the various complex and unusual forms of characters in which these tablets are written. In addition to the printed texts and autotype plates, a summary of the contents of each tablet is given, accompanied by notes, chiefly philological and geographical, which we believe will be of use to the reader. The summary is preceded by an introduction, in which the finding of the tablets and many points of interest concerning them are discussed in brief paragraphs. It will be remembered that some thirty years ago, when Sir Henry Rawlinson began to publish his monumental work, the "Cuneiform Inscriptions of Western Asia," he contemplated adding translations of all the texts given therein. It was, however, found impossible to do this satisfactorily; and notwithstanding Sir Henry's thirty years' additional labour on the Assyrian inscriptions, it would still be somewhat rash to publish word-for-word translations of such difficult texts as those from Tell el-Amarna. Plain, historical narrative, like the great Tiglath-Pileser inscription, could be and was well enough rendered into English by Sir Henry Rawlinson so far back as 1857; but letters and despatches of a new kind, containing words and forms hitherto unknown, cannot be thus treated. The summary of each tablet will tell the general reader what the tablet is about, and will help the student more than a literal translation of the verbose Oriental phrases would have done. In publishing these texts with autotype reproductions and summaries of contents, the Trustees of the British Museum have made a new departure, and we believe that the edition will be as useful to the general student of antiquity as to the cuneiform expert.

A TEXT-BOOK OF PHYSICS.

A Manual of Physics. By William Peddie, D.Sc., F.R.S.E. (London: Baillière, Tindall, and Cox, 1892.)

THE attempt made by Dr. Peddie to supply a manual of physics suitable for English students and English teachers is altogether worthy of praise, and his effort has undoubtedly been, on the whole, successful. The best works at present in use in higher schools and in colleges as text-books of physics are the well-known English translations of two French books, Ganot and Deschanel. These are, no doubt, excellent books in their way, and in the hands of able English translators the original French compilations have received great improvement. A recommendation also of these French books is to be found in the beautiful diagrams and pictures of experimental apparatus. These we miss in every English book, including the book before us. Nevertheless, even the modified and improved English translations are not altogether satisfactory for English teaching purposes, and Dr. Peddie's work, supplying a need which is very generally felt, will be most warmly welcomed.

The subject has been, on the whole, judiciously treated. It is compressed in an admirable way into very moderate compass. If, now and then, one feels regret that some particular portion has not been more fully dealt with, reflection on the moderate size of the book, and on the way in which each part is treated in the space prescribed to it by the author, often affords a timely and sufficient consolation.

While speaking about size and form, it may be remarked that the paper, the printing, and the binding, make this a pleasanter text-book to hold and to use than any which has appeared for many a day. In this respect the book can scarcely be too highly praised.

Commencing with four preliminary chapters, in which general laws are stated and explanations given as to certain necessary mathematical ideas and formulas, the author proceeds in chapter v. to the treatment of elementary kinematics; and in chapter vi. to the general principles of dynamics, including the general equations of fluid motion and of the equilibrium of a fluid. It is needless to say that these subjects are very briefly touched upon; but teachers will at any rate find a very succinct indication, to say the least, of the parts of mathematics and of dynamics which are most essential to a proper understanding of the physics which is to follow.

Chapters vii. to xiii. inclusive are devoted to properties of matter: general properties of solids, liquids, and gases are dealt with; a good account of gravitation is given; elasticity, diffusion, and the allied subjects, as well as cohesion and capillarity, are discussed; while in chapters xii. and xiii. we find a very fair account—short, of course—of atomic theories, including the modern kinetic theory of matter. Perhaps the chapters just referred to, on properties of matter, constitute the most thoroughly successful portion of the book. We cannot call to mind any book in which an account of these subjects so good, and in itself so complete, can be found. The remaining chapters—with the exception of the last two, which are devoted to the electromagnetic theory of light and "the ether"—treat in detail of sound, light, heat, electricity, and magnetism. It is in the last-named portion of the book that students will feel a want of fuller and more complete treatment. The subject of heat in particular will be felt by many to be unduly compressed, and the same must be said of parts at least of electrodynamics and electromagnetism.

A book such as we have described, covering so wide a field, and brought into the narrow limits of 500 small octavo pages, must obviously, if it be well arranged and well written, be an important contribution to our scientific literature. We have no hesitation in giving it high commendation. There is, perhaps, not much that is absolutely novel in the treatment of the subjects, or in the matter, but that is hardly to be expected in a manual of this kind: the novelty is rather to be seen in the idea of the production of such a book.

While thus giving to the author warm praise and congratulation, we cannot avoid noticing serious faults both of commission and omission. First it seems simply deplorable to drag quaternion notions and notation into an elementary book of this kind, unless it be to show how ridiculous the riders of the quaternion hobby can at times become. The explanations and definitions at the commencement of chapter v. will be nothing to the majority of learners and teachers but a mass of confusion thrown over one of the simplest and most important of subjects. To prove by quaternions the formula $S = VT$ (space described in a given time with constant velocity), which needs only a knowledge of the multiplication table; or the formula $x = \frac{1}{2}gt^2$ for falling bodies, which can be explained by common-sense (but not by quaternions) to a boy of twelve in half an hour, is simply inexcusable. Wherever quaternions are introduced in this book we find an easy matter made difficult—if not, as in the case of simple harmonic motion, absolutely unintelligible. Unfortunately, Dr. Peddie is not the first writer who has contrived, by means of quaternions, to make a subject unnecessarily difficult and repulsive.

But by far the most serious defect of this book, and it is one which will greatly mar both its usefulness as a text-book and also its popularity as a somewhat elementary work for reading and consultation, arises from the failure of its author to catch, even in a remote degree, the spirit which has animated and directed the whole of the best experimenting in physics for the last twenty-five or thirty years. *Et ignem regunt numeri* is the motto of Fourier's great work; and a realization of the fact that numbers (not merely numerical ratios) must be sought for as the crown of physical laws is that which has given pre-eminent value to the labours of experimenters during the last half-century, and has forced workers in this great field into precision and definiteness. The example set by Gauss and Weber, Joule and Thomson, and by the British Association Committee on Standards of Electrical Resistance appointed in 1861, has revolutionized ideas as to what is the ultimate object of experimenting in physics; and we can no longer be satisfied with knowledge as to almost any physical phenomenon until we are able to apply to the phenomenon and to our laws the searching test of arithmetical calculation in absolute numbers.

Unfortunately, in the book before us there is no recognition of these necessary conditions for completeness of knowledge, and very little recognition of recent investigations of the kind here indicated. The failure will be felt most seriously in the important subjects of heat, magnetism, and electricity.

In electricity there is not to be found the resistance, whether in ohms or in C.G.S. units, of any wire of any material! There are pages of algebra on dimensions of units, to puzzle the unfortunate learner, but nowhere can he find what an ohm, or ampere, or volt is: unless, "$ohm = 10^9$ *C.G.S.*" can be taken as a definition, when the meaning of a C.G.S. unit is not explained. Faraday's laws of electrolysis, got fifty years ago, are stated; but the determinations of Lord Rayleigh and Kohlrausch of the amount of silver deposited by an ampere current in a second are not even referred to. Tait's thermo-electric curves, and some forms of galvanic cells are described; but how to find the electromotive force of any one combination in volts is not indicated. We must not multiply instances. It would be only wearisome. Magnetism, electro-dynamics, are treated in precisely the same way; and the student would find it impossible to calculate from data in this book how much heat is conducted across a stone slab in an hour under given conditions, or how much heat is lost from the surface of a sooted globe in a minute, though there is a great deal of exposition of laws of heat exchanges, and of the algebra pertaining thereto. Diffusion of matter is another subject which suffers from defective treatment in a similar way. The word "diffusivity," introduced by Thomson, is correctly defined on p. 131; but ten lines lower down the definition is departed from, and a column of relative numbers is substituted for the now fairly known absolute diffusivities. A very thorough change of all these parts of the book ought to be made in a reprint or new edition, in order to make the work conformable to modern knowledge and requirements.

It would be ungracious to point out too many minor faults in a first edition; but a few must be mentioned. Faraday seems to have been forgotten in connection with liquefaction of gases! and Melloni, though not perhaps absolutely trustworthy, surely deserved to have his name mentioned in connection with radiation of heat. Mayer's name is not mentioned; and, whatever Dr. Peddie may think on the subject of the celebrated controversy, no one will agree with him that the name should be *omitted*. We cannot help feeling that there is too much local colouring about many parts of the book. A book of this kind is sadly marred by want of proportionate distribution of treatment; even the occupation of space with minute treatment of a favourite subject becomes an injustice with regard to those subjects which are unduly curtailed for want of more space. We trust it will not hurt the feelings of anyone if we remark that the book should be a little more cosmopolitan, and a good deal less Scotch.

On p. 337, there is a mistake which will bear comparison with Lord Brougham's celebrated idea that people carry weights on their heads to have them farther from the centre of the earth, and therefore less attracted. The formation of ice in "very hot" countries on shallow pools is compared with Faraday's experiment of freezing mercury in a white-hot crucible. It is radiation, not forced evaporation, which is the cause of the phenomenon referred to.

We regret, also, that Dr. Peddie has thought it advisable to follow the example of Maxwell and others in changing Andrews's diagram right for left. There is no reason for doing so. The diagram was much better as Andrews originally gave it; and it would be better also without the dotted line said to separate the region in which liquid and gas can exist together from the regions in which the substance is entirely liquid or entirely gaseous. The former is a region concerning which there has been much speculation of an unprofitable sort. The elementary student need not be troubled with it, and it cannot be explained to him in a single sentence.

On p. 95 there is a diagram of a cord being pulled through a tube. Perhaps it cannot be asserted that the diagram is absolutely wrong, because the cord is said in the text to be perfectly flexible. But the cord, passing round corners which look as if they were sharp angles, is so strikingly unlike anything which can be realized (and the results explained in this section can to a great extent be experimentally realized), that the diagram becomes at least misleading. If the corners are sharp by intention, then the diagram *is* absolutely wrong.

In spite of the faults and defects we have been obliged to notice, this book is, as we have said, an admirable attempt at a very worthy object, and with some remodelling it can be made into an excellent text-book. We wish it all success, feeling well satisfied that it meets a decided want.

OUR BOOK SHELF.

The Dietetic Value of Bread. By John Goodfellow, F.R.M.S. (London: Macmillan and Co.)

THIS book is another addition to the useful series of "Manuals for Students," published by Messrs. Macmillan and Co. The author states in his preface that the object of the work is twofold. First, to lay before the general public an account of the various kinds of bread, by which their merits may be judged; and, secondly, to afford technical information to students and others on the important subject of the true value of bread as a food. These objects have in every way been fulfilled. No one is more qualified to write such a book than Mr. Goodfellow, who by his previous writings has shown such a grasp of the subject with which he has to deal.

The first section of the volume is concerned with "Food, Diet, and Digestion." This is a very difficult matter to treat in a popular manner. It involves some of the most complicated problems of physiology. The author, however, has not shirked his task; anyone, however ignorant he may formerly have been on the processes by which food matters are rendered suitable for absorption and after-use by the human organism, if he reads through these pages carefully, cannot but help gaining much knowledge on the functions of the stomach and intestinal canal, and of the waste and work of the body.

The nature of the digestive fluids is not, of course, considered with the minuteness of detail necessary for a medical examination, but enough is said to render the following sections perfectly intelligible, although they are treated in a scientific manner.

"White Bread" is first considered. An introductory chapter is given describing the structure of the wheat grain, and the changes which flour undergoes when exposed to heat and the process of fermentation. Not only are the chemical and physiological properties of bread considered, but economical principles are gone into, and it is shown "that bread is one of the cheapest foods, not only with regard to the actual weight of nourishment obtained, but also with regard to the variety of the nutrient constituents; and the purchaser who expends his modest 2½*d.* in a 2-lb. loaf may rest assured that he could not spend his money to better advantage."

We further learn, however, that white bread is not a perfect food; those who partake of it should take care to supplement it largely with other foods, in order to make up for the lack of calcareous matter. On no account should it form part of the diet of children unless supplemented by milk or other foods rich in lime and phosphates.

Turning to "Whole-meal Bread," full descriptions are given of its composition, amount and nature of the salts present and their solubility; its digestibility, the waste present, and the action of bran on the intestine; its flavour, satiety, and dryness; and its effects on infants and children.

The ordinary whole-meal bread is not a desirable food, and far inferior to good white bread as regards the weight of actual nourishment and the thoroughness of the digestion. Its ingestion is often followed by diarrhœa, and the action of the bran increases the waste of food.

After a short consideration of some special forms of bread, such as "aërated," "bran," "rye" bread, &c., Mr. Goodfellow proceeds to speak of Meaby's Triticumina bread, of which he has a very high opinion, and believes that it is as near a perfect food as such a bread can be, and deserves the universal commendation which has been accorded to it by the medical and analytical world. "Germ," "diastase," "gluten" bread, &c., are then described, and the book finishes with short chapters on the diseases of bread and its medicinal properties.

To all who are interested in this subject, or wish to extend their knowledge of "the staff of life," we heartily recommend this volume.

Graduated Mathematical Exercises. Second Series. By A. T. Richardson, M.A. (London: Macmillan and Co., 1892.)

ON a previous occasion we have referred to the first series of exercises by Mr. Richardson. In these he led the student through a set of graduated examples, commencing with arithmetic and reaching those on cube root, compound interest, and quadratic equations.

In the present series, which is intended to be a continuation of the first, the relatively higher flights of mathematics have been dealt with. The problems have been arranged on the same lines, the more difficult of them being reached as advance is made, and include those on algebra, logarithms, trigonometry, mechanics, and analytical geometry.

An idea of the range over which each subject spreads can be gathered from the fact that all the problems will about suffice to cover such examinations as those of the Oxford and Cambridge Locals, and Army and Navy, allowing a small margin of safety.

Great care seems to have been taken to insure accuracy, every example having been worked out at least twice. For class work these examples will be found handy and a great saving of time, while for use at home the book should be widely employed.

Bibliothek des Professors der Zoologie und vergl. Anatomie, Dr. Ludwig von Graff, in Graz. (Leipzig: Wilhelm Engelmann, 1892.)

PROF. VON GRAFF is the lucky owner of a fine scientific library, which was formed mainly by Carl Theodor von Siebold, his father, and his grandfather, all of whom were professors. This library came into the possession of Prof. von Graff in 1882, and as it was too large for the modest dimensions of a German professor's house, he exchanged many books relating to practical medicine for zoological monographs and periodicals. At Graz the library is freely used by his assistants, pupils, and colleagues, and it is mainly for their benefit that the present catalogue has been issued. It consists of 337 closely printed pages, and is a compilation of considerable value, not only because it gives lists of authors and their works, but because of the admirable way in which the lists are arranged. The contents of the library are grouped under four headings—periodicals, auxiliary books (including works on University systems, bibliographical writings, dictionaries, &c.), *zoologia generalis,* and *zoologia specialis.*

The Canadian Guide-book. By Charles G. D. Roberts. (London: William Heinemann, 1892.)

TOURISTS and sportsmen in Canada ought to be very much obliged to Mr. Roberts for having provided them with this excellent Guide-book. The method he has adopted is that of Baedeker's Hand-books, and the result is in every way worthy of the models he has chosen. The work includes full descriptions of routes, cities, points of interest, summer resorts, fishing places, &c., in Eastern Ontario, the Muskoka district, the St. Lawrence region, the Lake St. John country, the maritime provinces, Prince Edward Island, and Newfoundland. In an appendix are given fish and game laws, and official lists of trout and salmon rivers and their lessees. The author generally compresses his information into as small a space as possible, but in dealing with the more interesting Canadian scenes has sought to make his descriptions lively and attractive. The volume is prettily printed, and is well supplied with maps and illustrations.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Question in Physics.

CAN there be a crowding of the particles of a gas to a much smaller compass without its being markedly heated? Can a gas expand without being cooled? It is probable that nearly every physicist will give negative answers to these questions, and yet the fact that such conditions may occur sometimes seems well established. The present writer, in 1889, attempted to determine the actual heating of air when compressed by a pump connected with the cylinder by a long tube, and found that the temperature was raised about 4° F. for a compression of 10 inches above atmospheric pressure. In like manner, on expanding this compressed air into the free atmosphere, it was found that the cooling was about 4°. These results were published in *Science*, vol. xv. p. 387, and were strongly combated by Prof. Ferrel and Prof. Marvin. Prof. Ferrel advanced, as applicable in this case, the well-known thermodynamic formula for the computation of the heat developed in a gas when compressed, as follows:—

$$\frac{t}{t'} = \left(\frac{p}{p'}\right)^{\cdot 291}$$

in which t and t' are the absolute temperatures corresponding to the pressures p and p'. Sir Wm. Thomson has given this formula in slightly different form, and with a larger exponent (see "Encyclopædia Britannica," vol. vii. p. 814). Prof. Ferrel found that, under the experimental conditions above, the heating should have been 43°, and the cooling 45°? (38°) (see *American Meteorological Journal*, vol. xii. pp. 339 and 340).

It seems very evident, however, that this formula can be used only when all the heat due to the work of compression is concentrated in the compressed air, and conversely when the air expands against an external resistance. An experiment by Joule will serve to elucidate this point. He determined the mechanical equivalent of heat by immersing the cylinder into which the air was to be compressed and the compressing pump in the same water-bath, and then determining the amount of compression and the total heat developed. This enables us to advance the proposition: *If air when compressed is to be raised to the temperature indicated by theory*, it is very *essential that all the heat developed in the work of compression should enter the air*. This seems self-evident; nevertheless, nearly all the errors that have entered the various discussions of this question have arisen from a neglect of this very obvious consideration.

In Joule's experiment let us suppose that the compressing pump had been in one bath, and the cylinder into which the air was compressed in another. Under these conditions, if no heat were lost, the first bath would have received very much the greater amount of heat. Now, if the compressed air in passing from the pump to the cylinder became cooled to the outside temperature, it is evident that all the heat due to the work of compression would have been disposed of outside the cylinder, and would not have been available for raising the temperature of the compressed air.

Instead of connecting the pump directly with the cylinder, let us take two cylinders of the same size, and connected by a tube. Compress the air in the first cylinder (A), to three atmospheres, the air in the other (B) being at atmospheric pressure. If we cool the air in A to the outside temperature, and then open the connection with B, the compressed air will rush from A to B, and an equilibrum will be established very quickly, the pressure in each cylinder being at two atmospheres. The air in A will be slightly chilled because of the work of imparting a certain velocity to the particles entering B, and the air in B will be slightly warmed from the impact of the particles rushing from A, but there will be no heating due to the work of an external force making the compression.

Instead of allowing the air in A to rush into B, suppose we open communication with the outside air. The resistance to the rush of air will be much less than before, and the chilling in A, due to the work of imparting a certain velocity to the air, would be slightly greater than in the previous case, but it is obvious that this will be vastly less than that given by the formula. We may say, then, that the conditions suggested by the questions above may be very easily brought about.

The compressed air in a cylinder has a potential energy or capacity to do work, and this energy may be transmitted to another cylinder having air at atmospheric pressure without loss, and plainly without imparting or losing any heat. We might compare it to the head of water in a pond. This water has a certain capacity to do work depending upon its head. We may enlarge the pond somewhat, and the capacity for doing work will remain almost unchanged. The extremely important bearing of these views upon problems in meteorology is very apparent. The convection theory of storms demands a cooling from the work of expansion in an ascending column of moist warm air; it would appear, however, that the cooling must be vastly less than has generally been considered probable.

H. A. HAZEN.

Aurora.

PERHAPS it may interest some of your readers to see a short abstract of the observations of aurora made here during the last months, this winter having been by far the richest in well-developed northern lights since the winter 1870–71. Beginning with the magnificent display of February 13, which lasted almost the whole night, sometimes with vivid red and green tints (it was first noted at 6h. 45m., and faded away in the moonlight between 15h. and 16h. astronomical time), and whose beams converged several times from a large part of the horizon towards the magnetic zenith (formation of corona was noted at 7h. 2m., 10h., and 13h.), we have had aurora on February 14, 15, 24, 25, March 1 (at 7h. high arch, with the highest part through α and β Cephei, 7h. 55m. corona, between 8h. and 10h. pulsating and flashing light, sometimes with apparently screw-formed motion), March 2, 3, 6 (at 10h. curtains and corona, yellow-green colours), March 24, 25, 26, 27, April 23, 24 (at 10h. 10m. curtains, yellow-green) April 25 (strong light visible through small openings in cumulo-stratus in the north). The last display was on May 1, with corona at 9h. 40m., after 10h. flashes, curtains, and beams, at 13h. beams. About 11h. there was a peculiar downward motion of reddish light near the north horizon.

The magnetic disturbances of February 13 were also the greatest we have had for some years. The magnetometers, of the Gaussian construction, are generally observed at 2h. and 21h., but on February 13 observations were made every hour from 11 p.m., in correspondence with Bosekop in Finmarken, where the German observers, MM. Brendel and Baschin, were taking magnetical observations and photographs of the aurora during February and part of January. In Christiania the perturbations were comparatively small in declination (westerly maximum 12° 35′ noted at 12h. 10m., minimum 11° 42′ at 15h. 18m., but neither of them absolute, the observations not being continuous); but the horizontal intensity, which had already begun to increase a little at 21h., February 12, varied by more than 0·03 C.G.S. units, a maximum of 0·171 having been noted at 2h. 30m., and a minimum of about 0·140 from 12h. 0m. to 13h. 20m.; as the mirror of the magnet was in both cases outside the scale, the values could only be roughly measured. At 16h. 0m. the bifilar had returned to the small end of the scale, but a nearly constant value of the horizontal intensity was only attained after 5h., February 14. The inclination had a maximum of 73° 18′ at 13h. 10m., from which it gradually diminished, with some fluctuations, towards the normal value, about 71° 0′.

With reference to Mr. Backhouse's observation of nacreous clouds in the morning of January 30 (Nature, xlv. p. 365), I may add that the same beautiful but as yet mysterious phenomenon was seen here January 30 and 31, both days in the south-west after sunset. Since the display of December 1885, mentioned by Mr. Backhouse, it has been seen here every year, except 1888, mostly for a day or two in January or February.

H. Geelmuyden.

University Observatory, Christiania, May 3.

Wave-Propagation of Magnetism.

In an interesting article in last month's *Philosophical Magazine*, Mr. Trowbridge has given an account of some experiments made by him with the view of examining for any indication of a definite rate of propagation in the magnetization of iron. In these experiments no indication was observed.

It seems to me, however, that nothing of this sort is likely to be observed where the magnetizing force is as great as that used by Mr. Trowbridge, and that there are two classes of disturbances to be carefully distinguished. For example, in Prof. Ewing's well-known magnetic model, something which looks very like a definite rate is to be seen in the case of a disturbance not sufficiently large to cause toppling over of the "molecule magnets"; that is to say, to cause the little magnets to pass through their positions of unstable equilibrium. On the other hand, with a larger disturbance the phenomenon visibly partakes of a different character. Here, throughout the medium, there are to be seen at irregular moments what may be considered as cases of precipitation of energy, owing to the occurrence of these positions of unstable equilibrium.

These two stages should be carefully distinguished, for an essential in wave-propagation as opposed to a rate of precipitation of energy (such as a rate of ignition, &c.) is obviously that the medium should not be permanently altered.

In some experiments made by me, very much smaller alternating currents than those used by Mr. Trowbridge were employed. But the occurrence of spurious effects, simulating to a remarkable degree the interference nodes looked for, must have effectually obscured in my experiments the true phenomenon, supposing its existence. So that, considering the conditions of both our experiments, I still think the subject requires further investigation before coming to a decision in the matter. Indeed, when larger currents are used, no indication is to be found of even these spurious effects.

In Prof. Ewing's model, when the magnets point on the whole the same way (representing a high state of magnetization), the rate of propagation of a small disturbance affords a more definite problem. Tried experimentally, this latter case might afford more satisfactory results. Fred. T. Trouton.

Correction in "Island Life."

In Dr. Merriam's recently published paper on "The Geographical Distribution of Life in North America," an important, and to me almost inexplicable error in my work "Island Life" is pointed out. It occurs at page 41 in the first edition, and is unfortunately repeated at the same page in the recently published new edition, and consists chiefly in stating that the moles (Talpidæ) are almost confined to the Palæarctic region. But a little further on in the same work (page 48 of first edition, and page 49 of second edition) it is correctly stated that there are three peculiar genera of moles in North America, and the same statement is made at page 115, and again at page 190 of vol. ii. of my "Geographical Distribution of Animals." At page 182 of vol. i. of the latter work, however, the error first appears, and it is this erroneous passage that has remained unnoticed till now, and was unfortunately repeated in "Island Life." In the same paragraph an error of a similar kind also occurs as to the distribution of the lynxes. To correct these errors pages 41 and 42 of the new edition of "Island Life" are being reprinted, and will be sent to all who possess the volume if they will forward a stamped and directed envelope to the publishers.

Alfred R. Wallace.

THE INTERNATIONAL CONFERENCE ON CHEMICAL NOMENCLATURE.

At the meeting of the International Chemical Congress, held in Paris in the summer of 1889, a special Section was appointed to consider the unification of chemical nomenclature, and, after discussing a variety of propositions, some of which were adopted, it was decided to form an International Commission for the further study of the subject.[1]

The members resident in Paris, having been constituted a permanent committee of the Commission, have devoted an immense amount of time and care to the preparation of a scheme, and it was to discuss their report[2] that we met at Geneva on Easter Monday last. The French Committee had issued invitations, not only to members of the Commission, but also to many other prominent chemists, so that the meeting was a thoroughly representative one. It is worth mentioning, as an illustration of the sympathetic treatment accorded by public bodies in France to men of science, that the Paris-Lyons-Marseilles Railway Company granted a reduction of one-half on the fare over their line to members of the Congress.

Very happily, the local committee had arranged that all might stay at the one hotel—the Métropole—and it was here that we first met in friendly union on the Monday evening.[3] The next morning the Congress assembled at the Hôtel de Ville, M. Richard, the Cantonal Minister of Education, being in the chair. After an admirable address of welcome from this gentleman, who appeared to thoroughly appreciate the importance of the object in view, on the motion of Prof. Cannizzaro it was wisely decided not to follow the complimentary, but somewhat unbusinesslike, Continental practice so frequently adopted, of appointing a different chairman each day, but to have only one. M. Friedel, who had taken the chair at all the numerous meetings of the Paris Committee, having been chosen by acclamation President of the Conference, formal business was at once entered into, and, after the necessary interval for lunch, the sitting was resumed in the afternoon. We met in like manner on the two following days, and the final sitting took place on the Friday morning, but many had left before this. On Tuesday evening, by invitation of the local committee, we visited the theatre, a very beautiful building. On the Wednesday evening, we were entertained by them at a dinner at the Hôtel Métropole, on which occasion a very striking speech was delivered by Prof. von Baeyer, who, after pointing out that experimental chemistry had been carried, early in the century, into Germany from France by Liebig, who was tutored by Gay-Lussac, proceeded to say that, although the science had now undoubtedly reached its highest development in Germany, it was more than probable that, in the future, circumstances would arise which would lead to some other nation—France, Russia, Italy, or England—coming to the fore. On this occasion, on the motion of M. Le Bel, it was unanimously decided to appoint M. Marignac Honorary President of the Congress, and a letter to him expressing our regret that ill-health prevented his taking part in its work was at once signed by all present. We were indebted in many other ways to the local committee, and there is no doubt that the success of the meeting was in large measure due to the forethought and hospitable care exercised by them on our behalf; absolute amity prevailed throughout, and it was clear that all were bent on co-operating to secure the carrying out to a successful issue of a very difficult but most important work. The great advantage to be derived from the personal intercourse which such meetings promote was soon apparent: gradually, the doubts which many entertained as to the possibility of devising a practical rational scheme of nomenclature were dispersed, and ere many hours had elapsed the sympathies of all present were enlisted on behalf of the work; thus a mission has been sent forth which will explain the enterprise to chemists generally.

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[1] The following chemists eventually consented to serve on the Commission:—MM. Béhal, Berthelot, Bouveault, Combes, Fauconnier, Friedel, Gautier, Grimaux, Jungfleisch, Schützenberger (all representing France), Graebe (Switzerland), Alexejeff and Beilstein (Russia), von Baeyer and Nölting (Germany), Lieben (Austria), Paterno (Italy), Franchimont (Holland), Armstrong (England), Istrati (Roumania), Calderon (Spain), Cleve (Sweden), Boukowski-Bey (Turkey), Ira Remsen (United States), and Mourgues (Chili).

[2] This report had been prepared by the following:—MM. Friedel (President), Béhal, Bouveault, Combes, Fauconnier, Gautier, and Grimaux.

[3] The following is the official list of those who took part in the Conference:—MM. H. E. Armstrong, professeur à la Central Institution, Londres, secrétaire de la Chemical Society; A. Arnaud, professeur au Muséum, à Paris; Adolphe von Baeyer, professeur à l'Université de Munich; Barbier, professeur à la Faculté des sciences de Lyon; Aug. Béhal, professeur à l'École supérieure de pharmacie de Paris; Louis Bouveault, docteur ès sciences, Paris; Stanislas Cannizzaro, professeur à l'Université de Rome; Paul Cazeneuve, professeur à la Faculté de médecine de Lyon; Alphonse Combes, docteur ès sciences, Paris; Alphonse Cosso, directeur de la Station expérimentale d'agriculture, à Turin; Maurice De Lacre, professeur à l'Université de Gand; Michel Fileti, professeur à l'Université de Turin; Emile Fischer, professeur à l'Université de Würzbourg; A.-P.-N. Franchimont, professeur à l'Université de Leide; Charles Friedel, membre de l'Institut, professeur à la Sorbonne, Paris; Dr. J. H. Gladstone, F.R.S., Londres; Carl Graebe, professeur à l'Université de Genève; Philippe-Auguste Guye, professeur à l'Université de Genève; Istrati, professeur à l'Université de Bucarest; Albert Haller, professeur à la Faculté des sciences de Nancy; Maurice Hanriot, professeur agrégé à la Faculté de médecine, Paris; A.-R. Hantsch, professeur à l'École polytechnique de Zurich; Achille Le Bel, docteur ès sciences, à Paris; A. Lieben, professeur à l'Université de Vienne; Léon Maquenne, docteur ès sciences, aide-naturaliste au Muséum, Paris: von Meyer, professeur à l'Université de Leipzig; Denis Monnier, professeur à l'Université de Genève; R. Nietzki, professeur à l'Université de Bâle; Emilio Noelting, directeur de l'École de chimie de Mulhouse; Emmanuel Paterno, professeur à l'Université de Palerme; Amé Pictet, privat-docent à l'Université de Genève; William Ramsay, F.R.S., professeur à l'Université de Londres; Zdenko-H. Skraup, professeur à l'Université de Graz; Ferdinand Tiemann, professeur à l'Université de Berlin.

Le Comité local d'organisation se composait de:—MM. Emile Ador, H.-W. de Blonay, Alex. Claparède, Professeur C. Graebe, Professeur Ph.-A. Guye, Alex. Le Royer, Professeur Denis Monnier, Amé Pictet, Fréd. Reverdin, Professeur Albert Rilliet, Edouard Sarasin.

The resolutions passed at the meetings are appended to this article. These, I think, are in no way to be taken as in all respects final, but they will serve to prepare the way and to indicate the lines on which the work is to be carried out. The position in which we found ourselves placed, in fact, was not one which justified our arriving at decisions which could fairly be regarded as binding. The report of the French Committee was placed in our hands only on the morning of the first meeting, and it was impossible to master its contents at so short a notice, and still less to criticize and test the application of its recommendations in detail. That the scheme would serve but as the basis for discussion was soon evident, when at the very outset a system of nomenclature for the hydrocarbons was adopted very different and far more significant than that recommended in the report; and numerous other departures from its recommendations were carried in the course of the proceedings. Again, some of the most active members of the Congress had confessedly paid attention only to special groups of compounds, and had not tested the application of proposals which they strenuously advocated to compounds of other groups; but as a nomenclature admirably adapted to one class may be open to all sorts of objections when applied to another, the general bearing of recommendations made with reference to special groups will have to be fully considered before they can be finally adopted. The resolutions relating to fatty acids (Nos. 18, 19) are of this kind, and their adoption was warmly opposed by an important minority on the ground that, however well they might be adapted to acids pure and simple derived from open-chain hydrocarbons, their application to acids derived from closed-chain hydrocarbons and acids containing other radicles in addition to carboxyl was beset with difficulty. In order to name an acid in accordance with this resolution, the formula of the corresponding hydrocarbon must be constructed from that of the acid by changing carboxyl into methyl; for example, citric acid, $CH_2(CO_2H).C(OH)(COOH).CH_2(COOH)$, would have to be regarded as a derivative of methylpentane, and would be named methylpentanoltrioic acid, numerals being added to indicate the positions of the hydroxyl and carboxyl groups; in like manner, mellithic acid, $C_6(COOH)_6$, would be named hexamethylbenzenehexoic acid, although no methyl is present in it. The mental effort involved in visualizing the formulæ from such names as these would appear to be far greater than if they were respectively named propanoltricarboxylic acid and benzenehexacarboxylic acid, or simply propanoltri-acid and benzenehexacid, the use of the term *acid* being understood to imply the presence of carboxyl. A decision on points such as these can only be arrived at after careful study of the general effect of such a proposal, and there was no time for such a comparison during the brief debate possible at a Conference. In some cases, there can be no doubt that the full force of objections raised to proposals in favour of which a majority subsequently voted was not felt, owing to the difficulty which necessarily arises at an international Conference if the language used be not equally familiar to all present, and consequently full expression cannot be given by all to their views. Moreover, although it is easy to criticize destructively even at short notice, constructive criticism under such circumstances is very difficult; consequently a proposal may be accepted even in face of serious objections to its adoption simply because nothing better can be suggested at the time. An instructive case of the kind arose on discussing thio-compounds. The proposals in the French report were not regarded as altogether satisfactory, and an amendment was suggested and carried which to many appeared most undesirable: the next morning, when the time came to confirm the resolutions arrived at on the previous day, the discussion was reopened, and a slight modification of the original proposal was suggested, which was recognized to be an improvement, and the objectionable resolution was rescinded. Clearly at such meetings much must depend on the right expression being found by happy inspiration at the right moment.

The one resolution which covers all others and which defines the nature of the task to be undertaken is the first. Whatever name we may choose to apply to a substance colloquially, it is clearly an absolute necessity of the times that every compound should bear a *systematic* name of such a character that it can be at once translated into the corresponding formula; and that, *vice versâ*, a name corresponding to any particular formula may be devised which we may count on finding in the *official* register, if the compound thought of have been described. The value of such a systematic nomenclature to original workers as well as to students cannot be over-estimated, and few who are qualified to take part in such a work will grudge the time they may spend on it. There was considerable difference of opinion at the meeting as to whether a systematic nomenclature should be devised merely for the purpose of an official register, or whether the object aimed at should be a system of wider application: the majority, I believe, came to the conclusion that it should certainly subserve the one, but if possible both purposes. There can be little doubt, however, that the future student will cut the knot by declining to burden his memory with a double vocabulary in the case of all but the commonest substances, and that therefore there is but one course open to us (cf. Res. 26).

Although sufficiently conservative to retain methane, ethane, propane, and butane, the Congress decided not to adopt the proposal to continue the use of the names formic, acetic, propionic, and butyric for the first four acids of the acetic series, which was advocated by a substantial minority on the ground that their retention would facilitate the change from the old to the proposed new system. This is one of the questions demanding careful consideration. Many will, no doubt, prefer to retain old unsystematic names as far as possible, but it is easy to see that the desire to avoid change may carry us too far in this direction; it will undoubtedly be very inconvenient to the present generation of chemists to abandon familiar and cherished names, but nevertheless it may be a wise course to boldly face the difficulty, rather than inflict on coming generations a partially illogical and unsystematic nomenclature. The argument that the present familiar names may still be used colloquially is, as I have already said, scarcely a justification of the dismissal of such names from the official nomenclature, as our successors may be expected to object more and more decidedly to a multiplex system as chemical science progresses, and to insist on the adoption of the official as the sole system: the extent to which familiar trivial names shall be retained in the official system is therefore a matter of great importance.

As one aim and object must be to devise a system which is significant and logical throughout, no considerations must be allowed to prevail which will defeat this, and it will not suffice to quote present usage in support of illogical proposals; but this has been done. Thus the Congress decided (Res. 46) to name compounds of the type $R'.N_2.R'$ *azo*-compounds, while retaining the name *diazo*-chloride for $C_6H_5.N_2Cl$. It matters not to us that the manufacturers have chosen to call the colours derived from *di*azo-compounds azo-dyes; if substances such as $(C_6H_5)_2S$ are termed *thio*, and compounds such as $(C_6H_5)_2S_2$ *di*thio-compounds (Res. 43), we are bound to be consistent, and apply the significant term diazo- to substances containing two nitrogen atoms. Resolution 46 ought therefore to be in part rescinded. I call attention to this case as an illustration of the tendency to break away from uniformity in favour of what may fairly be termed popular prejudice, which will require to be most carefully guarded against if the various sections of our system are to harmonize.

It will be gratifying to English chemists that the principle advocated for many years past by our Chemical Society, and enforced in its "Instructions to Abstractors"—that particular terminations should be regarded as indicative of particular functions, and should therefore be restricted to particular classes of compounds—has been legalized and extended by the Congress. This is a step of great importance, as we may expect that it will affect even trivial names, and that in future names will be given to new substances which will to a certain extent afford a clue to their nature; the hopeless confusion which now reigns supreme in the pages of the *Berichte*, for example, owing to the disregard of this principle by our German colleagues—who have hitherto been, as a rule, almost uniformly neglectful in matters of nomenclature—will, it may be hoped, ere long give way to more orderly treatment.

But the importance of applying this principle logically was not fully grasped even at the Congress, inasmuch as it was decided to affix the termination *ine* to acetylenic hydrocarbons, notwithstanding that this termination is admittedly indicative of basic properties. If, however, a suitable suffix ending in *ene* could be thought of, there would probably be little difficulty in securing its acceptance, in which case unsaturated hydrocarbons generally would have names ending in *ene*, and saturated hydrocarbons names ending in *ane*, and these terminations could be reserved exclusively for hydrocarbons.

It will be obvious from the foregoing remarks that although a solid foundation for our future system of nomenclature has been laid, much remains to be done before a mature design, perfect in all its details, can be presented for adoption. At the meeting the hope was expressed that a decision might be speedily taken, to enable Beilstein to utilize the proposals in the preparation of the third edition of his marvellous work; but it is clear that we are not yet so far advanced as to make this possible or even desirable, and it would be most unfortunate if Beilstein were at the present juncture to promulgate a system which is manifestly incomplete: nothing can be worse in such a case than to consent in haste, when it is evident that this would surely involve repentance at leisure.

Those of us who are interested in the work, and competent to advance it, must now test in detail the application of the proposals which have been provisionally adopted, and we must assist in contributing to the ultimate establishment of a system on the broad lines of policy laid down for our guidance at the Congress. As it is not improbable that in the future, owing to the extended use of our language, the major proportion of chemical students will speak English, it is essential that due attention be paid to the matter here in England, so that a system may be devised which we can make use of without difficulty.

HENRY E. ARMSTRONG.

Résolutions prises par le Congrès.

1. A côté des procédés habituels de nomenclature, il sera établi un nom *officiel* permettant de retrouver chaque corps sous une rubrique unique dans les tables et dictionnaires.

Le Congrès exprime le vœu que les auteurs prennent l'habitude de mentionner dans leurs mémoires, entre parenthèses, le nom officiel à côté du nom choisi par eux.

2. On décide de ne s'occuper, pour le moment, que de ce qui concerne les composés de constitution connue, et de remettre à plus tard la question des corps à constitution inconnue.

3. La désinence *ane* est adoptée pour tous les hydrocarbures saturés de la série grasse.

4. Les noms actuels des quatre premiers hydrocarbures saturés (*méthane*, *éthane*, *propane*, *butane*) sont conservés; on emploiera les noms dérivés des nombres grecs pour ceux qui ont plus de quatre atomes de carbone. Ces noms désigneront les hydrocarbures normaux.

5. Les hydrocarbures à chaîne arborescente sont regardés comme dérivés des hydrocarbures normaux, et on rapporte leur nom à la chaîne normale la plus longue qu'on puisse établir dans leur formule.

6. Le numérotage des chaînes latérales partira de l'atome de carbone terminal le plus rapproché d'une chaîne latérale; dans le cas où les chaînes latérales les plus voisines des extrémités seraient placées symétriquement, la plus simple décidera du choix.

7. Lorsqu'un résidu se substitue dans une chaîne latérale, on emploie *métho-*, *étho-*, etc., à la place de *méthyl-*, *éthyl-*, préfixes réservés pour le cas où la substitution se fait dans la chaîne principale.

8. Dans les hydrocarbures ayant une seule *double liaison*, on remplacera la terminaison *ane* de l'hydrocarbure saturé correspondant par la terminaison *ène* (ex. éthène); s'il y a deux doubles liaisons, on terminera en *diène* (ex. propadiène), s'il y en a trois, en *triène*, etc. Si cela est nécessaire, la place de la double liaison est indiquée par le numéro du premier atome de carbone sur lequel s'appuie cette double liaison.

9. Les noms des hydrocarbures à *triple liaison* se termineront pareillement en *ine*, *diine* et *triine* (ex. éthine pour acétylène. propine pour allylène, hexadiine pour dipropargyle).

10. Dans le cas où il y aurait simultanément des doubles et triples liaisons, on emploiera les désinences *énine*, *diénine*, etc.

11. En ce qui concerne les hydrocarbures saturés à chaîne fermée, ils prendront les noms des hydrocarbures saturés correspondants de la série grasse précédés du préfixe *cyclo* (ex. cyclohexane pour hexaméthylène).

12. Les atomes de carbone d'une chaîne latérale seront désignés par le même chiffre que l'atome de carbone auquel la chaîne est attachée. Ils porteront un indice qui indiquera leur rang dans la chaîne latérale en partant du point d'attache.

Dans le cas où deux chaînes seraient attachées au même atome de carbone, les indices de la plus simple d'entre elles seront accentués.

Le même mode de numérotage est adopté pour les chaînes latérales des chaînes fermées.

13. Les hydrocarbures non saturés seront numérotés comme les hydrocarbures saturés correspondants. Dans le cas d'ambiguïté ou d'absence de chaîne latérale, on placera le n° 1 au carbone terminal le plus rapproché de la liaison d'ordre le plus élevé.

14. Le numérotage des hydrocarbures est conservé pour tous leurs produits de substitution.

15. On nommera les alcools et les phénols du nom de l'hydrocarbure dont ils dérivent, terminé par le suffixe *ol* (ex. pentanol, penténol, etc.).

16. Quand on a affaire à des alcools ou à des phénols polyatomiques, on intercalera, entre le nom de l'hydrocarbure fondamental et le suffixe *ol*, une des particules *di*, *tri*, *tétra*, etc., suivant l'ordre de la polyatomicité (ex. propane-triol pour glycérine).

17. Le nom de *mercaptan* est abandonné, et cette fonction sera désignée par le suffixe *thiol* (ex. éthane-thiol).

18. Dans les acides de la série grasse, le carboxyle sera considéré comme faisant partie intégrante du squelette de carbone.

19. Le nom de tous les acides monobasiques de la série grasse est tiré de celui de l'hydrocarbure correspondant suivi du suffixe *oïque*.

On désignera les acides polybasiques par les terminaisons *dioïque*, *trioïque*, *tétroïque*, etc.

20. Les résidus monovalents des acides seront dénommés en transformant en *oyle* la terminaison *oïque* de l'acide.

21. Dans les acides monobasiques à chaîne normale saturée ou symétrique, le carbone du carboxyle porte le n° 1.

22. Les acides dans lesquels un ou plusieurs atomes de soufre remplacent autant d'atomes d'oxygéne du carboxyle seront désignés comme suit : le soufre simplement lié à un atome de carbone sera désigné par le suffixe *thiol* ; si la liaison est double, on emploiera le suffixe *thion*. Exemples :

$CH_3.CO.SH$ Acide éthane-thiolique.
$CH_3.CS.OH$ Acide éthane-thionique.
$CH_3.CS.SH$ Acide éthane-thionthiolique.

23. Le Congrès donne son adhésion à la proposition suivante sans émettre de vote définitif à ce sujet :

Les éthers-oxydes seront désignés par les noms des hydrocarbures qui les composent, reliés par le terme *-oxy-* (ex. pentane-oxy-éthane pour oxyde d'éthyle et d'amyle).

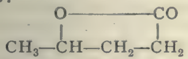
24. Les anhydrides d'acides conserveront leur mode actuel de désignation d'après le nom de leurs acides (ex. anhydride éthanoïque).

25. (12 *bis*). Dans le cas de deux chaînes latérales attachées au même atome de carbone, l'ordre dans lequel ces chaînes seront énoncées correspondra à leur ordre de complication.

26. Une discussion plus approfondie sur la nomenclature des composés à fonctions complexes est ajournée, et l'étude de cette question est renvoyée à la Commission internationale, pour qu'elle prépare sur ce point un projet qui sera présenté à un prochain Congrès ; la Commission cherchera à concilier les exigences de la nomenclature parlée avec celle d'une terminologie applicable aux dictionnaires.

27. On conservera les conventions habituelles pour les sels ou éthers composés.

28. Les lactones seront désignées par le mot *olide*, indiquant que c'est un anhydride interne d'alcool et d'acide. La position de la fonction alcoolique, par rapport au carboxyle de l'acide alcool d'où dérive la lactone, pourra être exprimée par les lettres grecques α, β, γ, δ, à côté du numérotage habituel des chaînes latérales :



$$\begin{array}{ccccccc} & & \mathrm{O} & \text{—} & \text{—} & \text{—} & \mathrm{CO}\\ & & | & & & & |\\ \mathrm{CH_3} & \text{—} & \mathrm{CH} & \text{—} & \mathrm{CH_2} & \text{—} & \mathrm{CH_2}\end{array}$$

1.4 pentanolide ou 1.4 γ pentanolide.

29. Les acides lactoniques dérivant d'acides bibasiques seront nommés comme les lactones dont ils dérivent, en ajoutant le suffixe *oïque*, caractéristique des acides.

30. La discussion sur les chaînes fermées est ajournée jusqu'au moment où la publication des idées de M. Armstrong, sur ce sujet, aura permis à la Commission internationale de les comparer avec les propositions de M. Bouveault.

31. Dans la série aromatique et tous les corps renfermant une chaîne fermée, toutes les chaînes latérales seront considérées comme des substituants.

32. Aldéhydes. Seront désignées par le suffixe *al* (méthanal, éthanal).

Aldéhydes sulfurées ; suffixe *thial*.

33. Acétones : suffixe *one* ($CH_3.CO.CH_2.CH_3$, butanone 2).

Diacétones, triacétones : suffixes *dione*, *trione*.

Acétones sulfurées : suffixe *thione*.

34. Quinones : Le suffixe *quinone* sera conservé pour les corps homologues de la quinone ordinaire.

Les corps ayant plusieurs fois le chaînon CO.CO seront des diquinones ou triquinones.

35. Ammoniaques composées : pas de changement (ex. éthylamine, éthène-diamine).

Les corps où le groupe bivalent —NH— ferme une chaîne formée de radicaux positifs seront appelés *imines* (ex. éthène-imine).

Phosphines, arsines, stibines, sulfines : la nomenclature en usage est conservée.

36. Hydroxylamine : ce nom est conservé.

37. Oximes : seront désignés en suivant les règles actuellement admises ; les corps *isonitrosés* seront nommés comme oximes.

(Ex. $CH(NOH).CH_2.CH_2CH_3$ 1 Butanoxime
$CH_3.CH_2.C(NOH).CH_3$ 2 Butanoxime.)

38. Amides : ce nom sera conservé (ex. Ethanamide

$NH_2.CO.CH_2.CH_2.CO.NH_2$ Butane-diamide
$COOH.CO.CH_2.CH_2.CO.NH_2$ Acide butanamidoïque).

Imides : seront conservées.

Amidoximes : ce nom sera conservé.

(Ex. $CH_3.C(NOH).NH_2$ Ethanamidoxime.)

Urée : le mot générique *urée* sera conservé, on l'emploiera comme suffixe pour les dérivés alcoylés de l'urée, tandis que les dérivés par substitution acide seront des *uréides*.

Les corps dérivant de deux molécules d'urée seront désignés par les suffixes *diurée*, *diuréide*. Les uréides acides prendront le nom d'*acides uréiques*. On rejettera les désinences *uramique* et *urique*.

39. Amidines : ce suffixe sera conservé.

(Ex. $CH_3.C.NH.NH_2$ Ethanamidine).

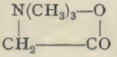
Pour les dérivés, le nom sera dédoublé, et l'on fera précéder du nom du groupe substituant, soit amino, soit amidine, suivant le cas.

(Ex. $CH_3.C(NC_2H_5).NH_2$ Ethanaminoéthylimidine.
$CH_3.C(NH).NHC_2H_5$ Ethanéthylamino-imidine.)

Guanidines : le mot générique *guanidine* est conservé, mais différentes guanidines seront nommées comme dérivés substitués de la diamidocarbo-imidine.

40. Bétaines : suffixe *taïne*.

(Ex.



$$\begin{array}{ccc}\mathrm{N(CH_3)_3} & \text{—} & \mathrm{O}\\ | & & |\\ \mathrm{CH_2} & \text{——} & \mathrm{CO}\end{array}$$

Ethanoyltriméthyltaïne.)

41. Nitriles : la question est laissée en suspens pour la série grasse. Pour la série aromatique, on adopte le préfixe *cyano* (comme nom de substituant).

42. Carbylamines : la nomenclature actuelle est conservée.

43. Sulfones : ce nom est conservé.

(Ex. $C_6H_5.SO_2.C_6H_5$ Benzène-sulfone-benzène.)

Sulfures : on les désignera en intercalant *thio* entre les noms des deux composés saturés (décision provisoire).

(Ex. $C_6H_5.S.C_6H_5$. Benzène-thio-benzène.)

Disulfures : seront désignés de même par *dithio*.

44. Ethers isocyaniques : suffixe *carbonimide*. Ex. Ethylcarbonimide désignera le cyanate d'éthyle de Wurtz ; on dira de même éthylthiocarbonimide pour le dérivé sulfuré correspondant.

Cyanates : ce nom est conservé aux vrais éthers qui, par saponification, donnent de l'acide cyanique ou ses produits directs d'hydratation. On remplacera le nom de sulfocyanate par celui de *thiocyanate*.

45. Corps nitrés : rien à changer à la nomenclature actuelle.

46. Corps azoïques : les dénominations *azo* et *diazo* seront conservées, mais le mode d'énonciation de ces composés sera modifié comme suit :

(Ex. $C_6H_5.N_2.Cl$ Chlorure de diazobenzène.
$C_6H_5.N_2.C_6H_5$ Benzène-azo-benzène.
$C_6H_5.N_2.C_6H_4.N_2.C_6H_5$ Benzène - azo - benzène - azo-benzène.)

THE GEOLOGY OF BARBADOS.[1]

THE oceanic series of Barbados forms a group of beds which is clearly marked off from the Scotland series below, and the coral limestone above. The oceanic deposits do not, however, appear everywhere as a continuous band between the two other formations, because the elevation of the island from oceanic depths was accompanied by a considerable amount of faulting, and tracts of the oceanic deposits were dropped down between blocks of the Scotland series. Although this faulting

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[1] "The Geology of Barbados. Part II. The Oceanic Deposits." By A. J. Jukes Browne and J. B. Harrison. Abstract of paper printed in the Quarterly Journal of the Geological Society, May 1892.

interferes with the continuity of the oceanic deposits, it is abundantly clear from numerous sections that they rest unconformably upon the Scotland series, and are as distinct in respect of age as they are in respect of lithological composition, and a greater contrast in all respects can hardly be imagined than these two formations present.

The oceanic series is more than 300 feet thick, and is divisible into five portions, which, however, blend into one another. These are, in descending order—

(1) Grey siliceous mudstones, consisting chiefly of fine volcanic dust, with a few fragments of siliceous organisms.

(2) Very fine-grained argillaceous earths, often red or pink, but sometimes yellow or buff; these are analogous to modern oceanic "red clays."

(3) Pulverulent chalky marls and earths, being consolidated foraminiferal oozes passing down into calcareo-siliceous earth with Radiolaria; proportion of carbonate of lime, 80 to 44 per cent.

(4) Siliceous Radiolarian earth, consisting mainly of Radiolaria, with sponge spicules and Diatoms, and a small amount of fine calcareous matter.

(5) Calcareo-siliceous earths, with 25 to 40 per cent. of carbonate of lime passing down into purer chalky earth, with 60 to 80 per cent., which is in some places converted into limestone by the infiltration of calcite.

There is a considerable variation in the amount of chalky matter even on what appears to be the same horizon, and within short distances. The whole series is more calcareous in the northern than in the southern part of the island.

Interstratified layers of volcanic sand and dust occur at several horizons, some of them being light grey pumiceous and felspathic sand, and others a mixture of such material with Radiolarian earth stained brown by what seems to be petroleum.

With respect to organic remains, the calcareous earths have yielded *Foraminifera* in abundance, a preliminary examination of six samples by the late Dr. H. B. Brady resulting in the discovery of 81 species. The siliceous earths have furnished the specimen of *Cystechinus crassus* recently described by Mr. J. W. Gregory, and they abound in Radiolaria, as is very well known. Certain marls and limestones on Bissex Hill prove to consist mainly of *Globigerina*.

The bearing of these fossils is discussed with regard to (1) the age, (2) the conditions of depth, at which the deposits were formed. The age is Pliocene, or Pleistocene, while stratigraphical considerations make it most probable that they are of Pliocene date.

The depth of water indicated by the Foraminifera is from 500 to 1000 fathoms, according to Dr. Brady. The *Cystechinus* is considered by Mr. Gregory as strong evidence for a depth of over 1000 fathoms, and is quite consistent with a depth of over 2000; while the Radiolaria are, in Prof. Haeckel's opinion, most nearly allied to those which occur in the deepest parts of modern oceans, *i.e.* about 3000 fathoms.

The coloured clays are remarkable for the almost complete absence of carbonate of lime; they correspond in all essential points to those modern argillaceous oozes which occur at from 2500 to 3000 fathoms, and have little or no carbonate of lime.

The available evidence points to the conclusion that the depth of water varied from 1000 to 2500 fathoms, and there may have been two epochs at which it was over 2000 fathoms.

Radiolarian deposits have for some years been known to exist in Trinidad, and the authors, having obtained samples, are able to announce that these closely resemble the Barbadian earths in general aspect, in chemical composition, and in microscopical structure. Similar earths also appear to exist in Hayti.

Finally, they discuss the changes in physical geography which are indicated by the existence of these deposits, and their probable equivalent in part of the white limestone of Jamaica; and they infer that the whole Central American and Caribbean region was deeply submerged during the Pliocene period, and that during this time there was open and free communication between the Atlantic and Pacific Oceans. The separation of the two oceans, and the deflection of the Gulf Stream, were changes accomplished by the upheaval of which evidence was adduced in a former paper, and this upheaval is a comparatively recent event.

The minute structure of the rocks is described in reports presented by Mr. W. Hill and Miss C. A. Raisin; the former showing that the Barbados chalk is similar in all essential points to the Chalk of England.

EDUARD VON REGEL.

THE learned and genial Director of the St. Petersburg Botanic Garden, Dr. Eduard von Regel, died on April 27, in his seventy-seventh year. He was the son of a Gotha parson, and developed a taste for gardening while still quite young. During the hours that might have been given to play he was usually engaged at his favourite pursuit in his father's garden. After the usual course of education, he spent several years in various botanic gardens, and about 1842 he was appointed "Obergärtner" in the Botanic Garden at Zurich. Here, in conjunction with Dr. O. Heer, the celebrated palæontologist, one of whose daughters he subsequently married, he at once founded a Swiss journal for agriculture and horticulture, and was exceedingly active in promoting horticulture, both in writing and practically. In 1852 he founded the now well-known and still flourishing *Gartenflora*, which, however, he ceased to edit after 1885. He soon gained fame, and when the important post of Scientific Director of the St. Petersburg Botanic Garden became vacant in 1855, it was offered to and accepted by Regel, and held by him to the last. There he found a wide field for his energy and abilities: but although he accomplished much meritorious botanical work, Russia is far more indebted to him for the improvements he effected in horticulture generally than for his botany. At the time when he first went to St. Petersburg, gardening was at a very low ebb, and the vast strides that have since been made in this industry are very largely due to his untiring efforts. He wrote treatises, introduced superior varieties of fruits, vegetables, and flowers, and succeeded in gaining the influence and support of exalted persons for his projects both botanical and horticultural. It was mainly through his exertions, we believe, that the first flower-show was held in St. Petersburg. This was in 1858, and now such a thing is no uncommon event. He was also instrumental in getting botanists attached to the Russian exploring expeditions in Central and Eastern Asia, whereby the gardens and herbaria, not only of Russia, but of Europe, have been greatly enriched, and botanical science advanced. Regel himself elaborated many of the dried collections thus obtained, besides describing a large number of plants cultivated in the garden from seeds or bulbs sent thither by various travellers. One of the best of his numerous writings is a monograph of the genus *Allium*—"Alliorum adhuc cognitorum Monographia,"—the number of species described exceeding 250, including a large number previously undescribed, the fruits of the explorations in Asia. He was also joint author of an enumeration of the plants collected in Siberia by Semenoff, Radde, Stubendorff, and others. Although gradually declining in health during the last year or so, he continued to discharge the duties of his office; and although not so active with his pen as formerly, he contributed some descriptions of new plants to the *Gartenflora* as recently as February of the present year. Dr. Regel was the recipient of many honours in his adopted country, and he was elected a foreign member of the Linnean Society of London in 1890. This is the second of her few prominent botanists that Russia has lost within a year.

NOTES.

THE annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, 25 Great George Street, London, on Thursday and Friday, May 26 and 27, commencing each day at 10.30 a.m. Sir Frederick Abel, F.R.S., the President, will deliver an address on Thursday, May 26. The following papers will be read and discussed on the same day, as far as time permits:—(1) On experiments with basic steel, by W. H. White, F.R.S., Director of Naval Construction and Assistant-Controller of the Navy; (2) on the production of pure iron in the basic furnace, by Colonel H. S. Dyer, Elswick Works, Newcastle-on-Tyne; (3) on experiments on the elimination of sulphur from iron, by E. J. Ball, and A. Wingham, London; (4) on platinum pyrometers, by H. L. Callendar, London. On Friday, May 27, the following papers will be read and discussed:—(5) On the manufacture and application of chilled cast iron (Gruson's system), by E. Reimers, Technical Director of the Gruson Works, Madgeburg; (6) on valves for open hearth furnaces, by J. W. Wailes, Calderbank, near Glasgow; (7) on the calorific efficiency of the puddling furnace, by Major Cubillo, Trubia Arsenal, Spain; (8) on a practical slide-rule for use in the calculation of blast furnace charges, by A. Wingham, London; (9) notes on fuel, and its efficiency in metallurgic operations, by B. H. Thwaite, Liverpool.

THE annual meeting of the Society of German Men of Science and Physicians will be held at Nürnberg from September 12 to 18. At the same time and place there will be a meeting of the German Mathematical Association. In connection with these meetings there will be a mathematical exhibition, including models, drawings, apparatus, and instruments used in teaching and in research in pure and applied mathematics. The project has the support of the Bavarian Government, and those who are organizing the exhibition have secured the co-operation of various competent men of science, and of the mathematical departments of some colleges, besides that of prominent publishers and well-known technical institutions. Space will be granted free of charge to exhibitors.

PROF. ELISHA GRAY, Chairman of the Committee on the Electrical Congress to be held in connection with the Chicago Exhibition, is about to visit all the important electrical centres in the Old World. He will attend meetings of the different electrical organizations, and hopes to strengthen the interest of European electricians in the Exhibition.

WE learn from *Science* that Mr. Timothy Hopkins has made provision for the endowment and maintenance of the seaside laboratory at Pacific Grove recently established under the auspices of the Leland Stanford Junior University. The Hopkins Laboratory will be under the general direction of Profs. Gilbert, Jenkins, and Campbell. It will be open during the summer vacation, and its facilities will be at the disposal of persons wishing to carry on original investigations in biology, as well as of students and teachers. Microscopes, microtomes, and other instruments necessary for investigations will be taken from the laboratories of the University.

THE great surgeon Richet has been succeeded in the Paris Academy of Sciences by Dr. Guyon.

THE distinguished mycologist, M. Roumeguère, of Toulouse, died on February 29 at the age of sixty-three. He had been for fourteen years sole editor of the quarterly *Revue Mycologique*, and was the author of a number of mycological works, the best-known being "Cryptogame illustrée, Champignons d'Europe," with 1700 illustrations.

AN interesting course of lectures is being delivered in connection with the Palestine Exploration Fund. They are being given in the lecture-room of the Royal Medical Society. On Tuesday, Canon Tristram lectured on the natural history of Palestine. The following are the remaining lectures of the course:—May 31, twenty-seven years' work, by Mr. Walter Besant; June 7, the Hittites up to date, by Dr. W. Wright; June 21, the story of a "Tell," by Mr. W. M. Flinders Petrie; June 28, the modern traveller in Palestine, by Canon Dalton.

THE members of the Geologists' Association will make an excursion to Down on June 18. The directors will be Mr. W. E. Darwin and Mr. W. Whitaker, F.R.S. Having arrived at Urpington, the party will walk up the valley to Green Street Green, where shells and bones have been found in the gravel that forms the bottom of the dry upper part of the valley of the Cray. The walk will be continued through High Elms Park to Down (3½ miles from the station). From Down a short stroll eastward gives a good view of a fine chalk valley. An opportunity will be taken for examining the clay-with-flints which caps the chalk over the higher grounds. The formation of this clay will be discussed, with a notice of Darwin's remarks thereon, and with reference to other like deposits. The general geology of the district will also be described, and the marked features caused by the clayey covering over the chalk, by the fine escarpment of the lower London Tertiaries, and by the London Clay hills beyond. By permission of Mrs. Darwin, the house and grounds rendered classic as the residence of Charles Darwin (Down House) will be shown to members, and Mr. De B. Crawshay will exhibit specimens of the flint implements that have lately been found over the high grounds of the neighbourhood. Messrs. Allen will exhibit others. The return journey will be made across the Tertiary escarpment at Holwood Park, and then down the dip-slope of the Blackheath Beds, over Hayes Common to Hayes (a walk of four miles).

ON Saturday afternoon, May 28, Prof. H. Marshall Ward will begin at the Royal Institution a course of three lectures on some modern discoveries in agricultural and forest botany.

ORCHID-LOVERS find much to admire in the latest of Mr. William Bull's exhibitions. An enthusiastic writer in the *Times* describes Mr. Bull's orchid-house as "at present a dream of beauty."

EARLY on Tuesday morning some parts of West Cornwall were visited by an earthquake. The *Times* says that in the village of Manaccan, in the Lizard district, the shock was so severe that the villagers almost without exception were awakened from their sleep by the shaking of their beds and the rattling of articles in their rooms. Their houses, too, distinctly shook, and in one case a person who was awakened from his sleep saw the door of his bedroom thrown wide open. At Redruth, some 12 or 15 miles distant, the shock was also felt. At first it was thought there had been an explosion somewhere in the neighbourhood.

DURING the past week a complete change of weather conditions has taken place over the British Isles. The anticyclone which had lain over the country with such persistency for several weeks showed signs of giving way on the 12th, and during the two following days a large but shallow depression spread over the kingdom from west and north-west, while the wind shifted to south-westward with unsettled and showery weather. The temperature, though cooler, was somewhat high for the time of year, the maxima varying from nearly 60° over Scotland to 65° and 70° over England and Ireland. Solar halos were observed on several days, and thunder was reported from the North Foreland on the 13th. Subsequently the westerly winds increased in force, especially in Ireland, and the sea became rough on our exposed western coasts. Some decrease of temperature also occurred, the maximum readings after Sunday only reaching about 60° in a few places. The conditions have been favourable to rain, but the fall has been slight, except in the north and west, and there is still a large deficiency in nearly all parts of the United Kingdom.

The Royal Meteorological Society has published a third edition of "Hints to Meteorological Observers" (42 pages large octavo). It is pointed out in the preface that meteorological observations, to be of scientific value, must be made on a uniform plan, otherwise the results will not be mutually comparable. The directions given are clear and concise, and the various instruments, both desirable or necessary, for a station of the second order, at which observations are taken at least twice daily, are plainly illustrated. The work also comprises several tables which are essential to the proper reduction of the observations recorded. No one can doubt that, notwithstanding the regulations laid down by several Conferences, there is still want of uniformity, not only when comparing observations of one country with another, but even among the observers of our own country. Take, for instance, the observation of rainfall, temperature, sunshine, cloud, and fog. It would be easy to show that the methods employed by various observers differ considerably, especially as to what constitutes a rainy day and how snow is measured, while the estimation of fog is very uncertain. Sunshine values by various kinds of instruments are hardly comparable *inter se*, and the accurate observation of clouds, whether of height, motion, amount, or description, is undoubtedly difficult, and presents a stumbling-block to many observers. Therefore, we cannot but welcome the exertions of the Meteorological Society to obtain uniformity. The work in question will be found very useful for the purpose, and might perhaps be rendered more so, in future, by the addition of the most approved pictures of clouds, and fuller information as to the importance of their careful observation.

The Report of the Department of Marine (Ottawa) for the fiscal year ended June 1891, contains a report upon the Meteorological Service of Canada for the period extending from October 1, 1890, to October 31, 1891. This Service is divided into two branches: (1) the collection and utilization of observations taken simultaneously for the purposes of weather prediction, and (2) the reduction of observations taken by volunteer observers and others for climatological purposes. The publication of the results obtained from the second division has been continued annually, since the establishment of the Service in 1872; but it is now proposed to deal with the accumulated observations, and to publish them in a serviceable and readable form. This will be the first authoritative Government publication on the climate of Canada; and it will be useful for immigration purposes, and for showing the suitability of the climate, in various localities, for raising agricultural crops. It is expected that the work will require three years to complete. Among the stations in connection with the Canadian Service is one at Bermuda, towards the maintenance of which an annual contribution is paid to the Government of that island, and cable messages are received daily in the interests of the shipping on the Atlantic coast. The Cable Company transmit the messages at half the ordinary rates. Many severe storms have occurred in Canada since the last report, and in each instance warnings were issued from Toronto; of these 80·7 per cent. are stated to have been verified. Warnings of approaching snowstorms were also issued to railways, and it is proposed to extend this service to Manitoba, and as far west as Qu'Appelle.

An excellent paper on "The Art of Internal Illumination of Buildings by Electricity," was read by Mr. W. H. Preece, F.R.S., in the rooms of the Royal Institute of British Architects on Monday evening. In the course of his remarks Mr. Preece noted that the electric light was not always absolutely safe. Security was to be obtained only by good design, perfect materials, first-class workmanship, and rigid inspection. Imperfect materials erected by cheap contractors had led to many disasters. On the other hand, it was stated that no fire had occurred in buildings fitted up under the rules and regulations, and inspected by the officers, of the insurance companies in this country. In Mr. Preece's opinion, everything ought as much as possible to be kept in view, and the conductors ought not to be hidden under wainscots or floors or above ceilings. The glow lamp excited by three watts per candle was at present the most perfect source of domestic light, and when the patent expired—in a year or two—would be obtainable at about one-third of the present price.

Mr. W. B. L. Hamilton, writing in the American journal *Electricity* on "Electricity in the United States Navy," says the latest use of the electric motor in taking the place of human energy in the manipulation of the death-dealing Gatling gun has been found to work with great success. The Crocker-Wheeler Motor Company, at the request of the United States Navy Bureau of Ordnance, constructed a special type of motor, which is attached to the breech of the gun. Hitherto the services of two men have been necessary in the working of these guns—the gunner, whose duty is to train the gun and drop the shot, and another man to operate the crank which sets in motion the mechanism which causes the balls to hail down upon the enemy. The adaptation of the Crocker-Wheeler motor not only does away with the services of the latter, but enables the gunner to train and operate the gun at will by touching an electric button. So completely is the Gatling gun under the control of the gunner, that he is enabled to fire either a single shot, or to fire them at the rate of 1200 per minute.

Science of April 29 prints the following account of a fire-ball, by C. C. Bayley:—"A telephone wire was supported on cedar posts 20 feet high and 20 rods apart. During August, 1889, we had a thunderstorm, during which there was a sharp and heavy crash. Several of the poles were found to have been struck, and portions to have been taken out through their entire length. One of these portions, of the size of a medium rail, was thrown into an adjoining field some rods from the pole. Portions from the others were smaller and more or less shattered. Near the southernmost pole struck, a family were in a house with doors and windows open, and a luminous ball seemed to leap from the wire, pass through the open door and a window, and pursue its course some rods through the open space behind the house. A boy in the room grasped his thumb and cried out, 'I'm struck,' and Mr. Hewett felt a sensation of numbness in his left arm for some time. A girl seized her shawl and rushed out of the house to chase the ball. She reported that she pursued it some distance, while it bounded lightly along, until it seemed to be dissipated in the air without an explosion. The size of the ball was about that of the two fists, and its velocity about that of a ball thrown by the hand."

We learn, from a Florentine source (*La Nazione*, May 3), that in the spring of the year 1890, Mrs. Zelia Nuttall, of the Peabody Museum of American Archæology and Ethnology, Cambridge, Mass.—whose interesting memoir on "Ancient Mexican Shields" was recently noticed in these columns—recognized the great importance of an anonymous Spanish-Mexican MS. preserved in the National Central Library of Florence.

This MS. has never been published. It is entitled "Libro de la vida que los Yndios antiguamente hazian, y supersticiones y malos ritos que tenian y guardavan" (*MSS. Magl.*, Class III., Pal. 11, Cod. 3). It treats of the costumes and religious rites of the ancient Aztecs, and is full of coloured designs which Mrs. Nuttall has had reproduced in *fac-simile* by photographic lithography. It is her intention to publish this MS., at her own cost, accompanied by a preface, an English translation of the text, and illustrative notes. It will be dedicated to the approaching Congress of Americanists, which will be held in Spain this autumn to celebrate the fourth centenary of the discovery of America. An edition of 200 copies will be issued, and held on sale at the Peabody Museum of American Archæology.

An interesting paper on the uses and applications of aluminium was read by Mr. G. L. Addenbrooke before the Society of Arts on May 11, and is printed in the current number of the Society's Journal. Referring to the applicability of aluminium to opera and field glasses, he said there was an example on the table of a glass made in 1864, which had ever since been in constant use. In 1870 the wheel of a carriage passed over it, but it was afterwards straightened out and made usable. It has made two voyages across the Atlantic, two across the Pacific, and has had other shorter experiences of the sea air, besides lying on one occasion for some time in salt water. Mr. Addenbrooke has kept strips of aluminium for two or three weeks in salt water, and has noted very little effect.

Towards the end of last year—from November 21 to December 5—the members of the Victoria Field Naturalists' Club made an excursion to the Australian chains of hills called the Grampians. The excursion seems to have been remarkably pleasant, but the scientific results did not quite come up to the expectation. According to an account given in the Club's Journal, the botanists were far and away the most successful. A really good collection of plants of the district was obtained. In bird life there was little observable that is not so elsewhere nearer Melbourne; neither was there any great variety of snakes or lizards, and to the collectors of these, as also to the entomologist, the excursion was especially disappointing. From the well-known extensive variety of flowering shrubs in the Grampians, coupled with the fact that several are peculiar to the district, it was fully expected that at least a few clearly representative Lepidoptera or Coleoptera would be secured, but not a specimen of either family was seen that is not common in and around Melbourne.

Mr. E. H. Parker, the British Consul at Kiungchow, in Hainan, a large island off the southern coast of China, mentions a curious phenomenon in connection with the tides of that port. The tides inside the inner harbour, he says, require several years of careful observation before they can be tabulated. It appears certain, however, that there are always two tidal waves a day, though one is so much more considerable than the other that the effect is often practically that of one single tide in the twenty-four hours. The easterly and westerly currents through the straits are not necessarily connected with the rise and fall of the water, either there or in port. The phenomenon of "slack water" (*morte eau*) is also observable every ten days or so at Haiphong, and is probably owing to much the same causes as at Hoihow. At Tourane in Tonquin, too, it is popularly thought that there is usually but one tide within the twenty-four hours. This tide is felt away up to the citadel of Quangnam. In the Gulf of Tonquin the incoming tidal wave flows from the south, a fact which perhaps accounts for the singular circumstance that the westerly current in the Hainan Straits always sets for sixteen hours. One at least of the tidal waves from the east which pass Hoihow cannot get through the straits to Tonquin so soon as that portion of the same wave which takes a circuitous course by way of Annam.

The Pacific Coast Fisheries of the United States appear to be in a most flourishing condition. According to a recent census bulletin, they employed 13,850 persons in various capacities in the last federal census year; 6,498,239 dollars were invested in them, and the products were valued at 6,387,803 dollars. The canning of salmon is the most important fishery industry in the Pacific States.

Sisal grass, according to a Mexican authority quoted in the new number of the *Board of Trade Journal*, is likely to prove a very important source of wealth for Mexico. It grows in long, narrow blades, often to the length of four or five feet, and these, when dry, curl up from side to side, forming a flexible string, stronger than any cotton cord of the same size ever manufactured. It is in great demand among florists and among manufacturers of various kinds of grass goods; and it is said to be capable of being applied to many new uses. Ropes, cords, lines of any description and any size may be manufactured of it, and a ship's cable of sisal grass is one of the possibilities of the future. It is almost impervious to the action of salt water, and is not readily decayed or disintegrated by moisture and heat. It takes its name from the port of Sisal, in Yucatan, through which it was formerly exported.

A paper on modern aërial navigation was read by Captain J. D. Fullerton, R.E., before the Royal United Service Institution on Friday last. His object was to show that the science of aëronautics was based upon simple rules and common sense, and not upon wild and vague theories opposed to all principles of nature. He divided aërial navigation into two distinct branches: (1) ballooning, or navigation by means of machines lighter than air; and (2) aëration, or navigation by means of machines heavier than the air. Proceeding to discuss the first branch, the lecturer sketched the history of attempts at propelling balloons. Describing the requirements of a proposed war balloon, he said these were: (1) that it should be able to carry three or four passengers, a supply of explosive shells, and a machine gun or two; (2) that it should be able to travel at the rate of about 30 miles an hour on a still day, which would enable it to keep up with almost any warship afloat. In regard to aëration, Captain Fullerton said the chief characteristics of this system were that a large supporting surface, either in the form of wings or in that of an aëroplane, was used to carry the weight; that the lifting or supporting power of this surface was dependent upon its velocity and the angle of inclination which it made with the horizon; and that the horizontal resistance to motion depended upon the velocity and angle of inclination in the same manner. The great difficulty both in ballooning and aëration was to get a sufficiently light motor.

The first number of a new journal, called the *Canal Journal*, has been issued. Its aim will be "to assist the cause of canals and inland navigation generally." It promises to be of considerable value and interest to the class of readers for whom it is especially intended.

The German publisher, Friedrich Brandstetter, announces that he will issue in the course of the present year a second and improved edition of Dr. J. J. Egli's "Nomina Geographica." The number of explained names has been much more than doubled.

Further details concerning the nature and chemical behaviour of acetyl fluoride, CH_3COF, the new substance whose preparation and physical properties were described in our note of last week (p. 40), are contributed by M. Meslans to the current number of the *Comptes rendus*. It may be remembered that this interesting substance was shown to be liquid at temperatures below 19°·5, and gaseous at temperatures superior to this, its temperature of ebullition, both the liquid and the gas being colourless, and endowed with an odour somewhat reminding one of that of carbonyl chloride. In contact with water, acetyl fluoride is found to react eventually in a manner similar to its well-known analogue, acetyl chloride, forming hydrofluoric and acetic acids.

$$CH_3.COF + H_2O = CH_3.COOH + HF.$$

But there is a considerable difference in the degree of energy with which the decomposition occurs, for while the behaviour of acetyl chloride is almost violent, acetyl fluoride only reacts with great slowness. When a small quantity of the fluoride if dropped into water the two liquids do not mix, and the globule of fluoride only disappears after long standing. Strong solutions of potash or soda, however, decompose it rapidly, with formation of fluoride and acetate of the alkali. The action of caustic lime upon acetyl fluoride is interesting; the gas is rapidly absorbed by it, and calcium fluoride and acetic anhydride formed.

$$2CH_3.COF + CaO = CaF_2 + (CH_3.CO)_2O.$$

Ammonia gas reacts with considerable energy with the liquid, producing a white crystalline mass, consisting of ammonium fluoride and acetamide, $CH_3.CONH_2$. The latter may readily be isolated in good crystals by extraction with ether and subsequent evaporation. The gaseous fluoride reacts with ammonia in the proportion indicated by equation—

$$CH_3.COF + 2NH_2 = CH_3.CONH_2 + NH_4F\ ;$$

that is, two volumes of ammonia react with one volume of acetyl fluoride gas. Aniline likewise acts with energy upon the liquid, forming hydrofluoric acid and acetanilide, $C_6H_5.NH.CH_3.CO$. The action of absolute alcohol is peculiar; it dissolves the liquid fluoride in all proportions, but after an interval of a few hours, interaction occurs with production of hydrofluoric acid and acetic ether. The latter may readily be separated by the addition of water.

$$CH_3.COF + C_2H_5OH = CH_3.COOC_2H_5 + HF.$$

Acetyl fluoride is much more stable in presence of alkaline acetates than its chlorine analogue. Even after four hours' heating in a sealed tube to 100° with sodium acetate, only a small proportion of sodium fluoride and acetic anhydride were formed. Still more stable is acetyl fluoride towards sodium amalgam, there being no appreciable reduction to aldehyde or alcohol. Metallic sodium is likewise without action upon liquid acetyl fluoride, but when heated to redness in the gaseous fluoride, the metal decomposes it with incandescence, sodium fluoride being formed and carbon deposited, together with a few drops of a liquid whose characters have not yet been ascertained. From these reactions it is evident that acetyl fluoride is a substance of a much more stable character than its analogue, acetyl chloride.

THE additions to the Zoological Society's Gardens during the past week include an Egyptian Ichneumon (*Herpestes ichneumon*) from North Africa, presented by Dr. J. Anderson; a Ring-tailed Coati (*Nasua rufa*), a Kinkajou (*Cercoleptes caudivolvulus*), a Blue-bearded Jay (*Cyanocorax cyanopogon*) from Brazil, presented by Mr. J. E. Wolfe, C.M.Z.S.; two Laughing Kingfishers (*Dacelo gigantea*), from Australia, presented by Mrs. H. M. Stanley; two Grey Hypocoliuses (*Hypocolius ampelinus* ♂ ♀) from Scinde, presented by Mr. W. D. Cumming; two Ravens (*Corvus corax*), British, presented by Mr. Gregory Haines; a Crowned Horned Lizard (*Phrynosoma coronatum*) from California, presented by Mr. R. Thorn Annan; a Common Fox (*Canis vulpes*), British, three Palm Squirrels (*Sciurus palmarum*) from India, a Brown-throated Conure (*Conurus æruginosus*) from South America, deposited; a Grey-headed Porphyrio (*Porphyrio poliocephalus*) from Persia, purchased; a Persian Gazelle (*Gazella subgutterosa* ♂), a Vulpine Phalanger (*Phalangista vulpina* ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

LATITUDE OBSERVATIONS AT WAIKIKI.—The *Hawaiian Gazette* for March 8 contains an account by Mr. Preston, of the U.S. Coast Survey, of the latitude observations which are being made at Waikiki on the island of Oahu, Hawaii. In it we read:—"The motion of the pole is, of course, extremely small, and the effect is that here in Honolulu we are about 50 feet nearer the equator now than we were some months ago. This change does not, however, go on indefinitely, but the motion is such that the pole returns at the end of a year to nearly its original position. Besides this annual movement, there seems to be reason to believe that there is a secular change extending over a period of at least sixty years." But no definite conclusions can be arrived at until the observations made at Honolulu are discussed in connection with those made on this side of the earth. In order to test the theory that changes of latitude are produced by the movements of large masses of molten matter in the interior of the earth, the force of gravity is measured on every night that latitude observations are made. As this is done with the idea of detecting variations, the relative and not absolute intensity is all that is required. The arrangement employed is such that if from any cause the acceleration due to gravity should be increased by only one five-hundredth of an inch, it could be easily measured. The observations will be completed in the fall of the year, but the final results cannot be known before the latter part of 1893.

MOTION IN THE LINE OF SIGHT.—*Astronomy and Astro-Physics*, No. 104, contains a very important contribution by Mr. W. W. Campbell, on the reduction of spectroscopic observations in the line of sight. The paper contains an explanation of the construction and use of the tables, the limit of precision adopted being one-hundredth of a mile per second. The first table gives the velocities of the star corresponding to a known displacement of one tenth-metre in the various parts of the spectrum, from which the velocity corresponding to any observed displacement can be directly obtained. The formula

$$v_s = V_s \Delta\lambda$$

gives this velocity corresponding to any measured $\Delta\lambda$, V_s being taken directly from the tables.

Table II. gives the earth's orbital velocity, V_a, and the deviation, i, when the sun's longitude is $\odot$. These values are obtained from the formulæ—

$$\tan i = \frac{e \sin(\odot - \Pi)}{1 + e \cos(\odot - \Pi)}$$

and $$V_a = \frac{a}{\sqrt{1 - e^2}} \cdot \frac{2\Pi}{T}[1 + e \cos(\odot - \pi)] \sec i,$$

and when found are substituted in the equation—

$$v_a = - V_a \sin(\lambda - \odot + i) \cos \beta.$$

By tabulating V_a and i as functions of $\odot$, their values can be very easily found, and v_a consequently reduced from the last-mentioned equation.

The value of the lunar correction has been taken into account here, omitting any errors due to ellipticity of the orbit and its inclination to the ecliptic. Its value is obtained from the formula—

$$v_d = - 0{\cdot}29 \sin t \cos \delta \cos \phi,$$

the latitude used being that of Mount Hamilton, but corresponding corrections for any other latitudes can be found from these by multiplying them by $\frac{\cos \phi'}{\cos \phi}$, where ϕ' is the new latitude required.

THE LATE PARTIAL ECLIPSE OF THE MOON.—Fine weather was generally prevalent during the partial eclipse of the moon on May 11, affording many observers a good opportunity for noting any new features connected with such an occurrence. Considering that the eclipse was only a partial one, it may be rather difficult to decide whether it should be classed in the category of "bright" or "dark" eclipses. Undoubtedly it was not a very dark one, for during the greatest immersion the whole surface of the moon could be distinctly seen, especially with the help of a telescope, with which craters could be picked out. On the hypothesis that "dark" and "bright" eclipses are brought about owing to the different states of the solar atmosphere, the present one should have been at any rate more inclined to be "bright" than "dark," for as we are approaching a spot maximum the sun's atmosphere is becoming more and more disturbed. At the time of greatest obscuration the blood-red tinge, caused by the absorption of our atmosphere, became very apparent, but this gradually wore off as the brighter part of the moon made its appearance.

From a series of photographs of the eclipsed moon taken at intervals of about a quarter of an hour, the penumbra in some of them was very distinct, especially in those taken near the time of greatest obscuration, the exposures then being comparatively long. At mid eclipse an attempt was made to obtain a photograph of the whole disk of the moon, as it appeared so distinct and clear on the ground glass, but even an exposure of 12s., using extra rapid dry plates and a 30-inch reflector, was not sufficient to bring it out, although the extent of the bright crescent and penumbra was very much increased.

DECLINATIONS OF STARS FOR REDUCTION OF VARIATIONS IN LATITUDE.—No. 263 of the *Astronomical Journal* contains the declinations of thirty-six stars, which have been obtained with the prime-vertical transit of the United States Naval Observatory. The observations were made for the determination of the constant of aberration, and consequently at the periods of maxima aberration effects, but their present publication, as Prof. S. J. Brown states, is owing to the "many requests for the observed declinations of these stars for use in discussing probable secular and periodical changes in latitude." The stars in this list are comprised in the zone 36° 37′—38° 40′. The communication contains a brief account of the methods of reduction employed, together with a reference to the instrumental adjustments.

The same number of the *Journal* contains also some results of the observations of α Lyræ, made during the years 1862–67 with the same instrument as mentioned above. The discussion of these observations was first made when Euler's value of 306 days for the periodical variation of the latitude was in vogue, but Prof. S. Newcomb, in the present case, has taken Mr. Chandler's new value, and gives, briefly, the following results :—

Mean declination of α Lyræ for 1865·0, assuming the latitude of the centre of the Observatory to be 38° 53′ 39″·25	38° 39′ 35″·56
Correction to Struve's constant of aberration...	+ 0″·006
Hence, constant of aberration	20″·451
Parallax of α Lyræ	+ 0″·24
Coefficient of sun's azimuth in declination ...	+ 0″·507
Coefficient of sin N	$s = + 0''\cdot086$
Coefficient of cosine N	$c = - 0''\cdot087$

the value of N being assumed zero at 1864·50, increasing 308° annually.

The expression which he gives for the variation of the latitude of Washington is

$$\delta\phi = 0''\cdot122 \cos 308^\circ (t - 1864\cdot94),$$

the distance between the poles, or the semi-amplitude of the variation of the latitude, being 0″·122.

COMET 1892 DENNING (MARCH 18).—The following elements and ephemeris are given for this comet in the *Astronomische Nachrichten*, No. 3089, computed from three observations made at the Hamburg Observatory :—

$$T = 1892 \text{ May } 11\cdot22042 \text{ Berlin M.T.}$$

$$\left.\begin{aligned} \omega &= 129^\circ\ 18'\ 34''\cdot4 \\ \text{☊} &= 253\ \ 25\ \ 41\cdot6 \\ i &= \ \ 89\ \ 42\ \ \ \ 4\cdot3 \end{aligned}\right\}\text{ M. Equator } 1892\cdot0.$$

$$\log q = 0\cdot294619;$$

Ephemeris for 12h. Berlin M.T.

1892.	α App. h.	m.	s.	δ App. °	′	log r.	log. Δ.	Br.
May 19	3	49	27	+52	13·5			
20		52	26	51	57·7			
21		55	22	51	41·8	0·2947	0·4423	0·80
22		58	15	51	25·9			
23	4	1	5	51	10·0			
24		3	52	50	54·1			
25		6	37	50	38·2	0·2948	0·4466	0·79
26		9	19	50	22·3			

The brightness at the time of discovery is taken as unity.

COMET 1892 SWIFT (MARCH 6).—The elements and ephemeris of this comet are given in the *Edinburgh Circular* (No. 26), from which we make the following extract :—

1892.	R.A. h.	m.	s.	Decl. °	′	log Δ.	log r.	Br.
May 19	23	23	44	+31	52·2			
20		26	16	32	22·2			
21		28	47	32	51·6	0·1522	0·1035	0·53
22		31	16	33	20·4			
23		33	44	33	48·7			
24		36	10	34	16·5			
25		38	34	34	43·7	0·1628	0·1166	0·47
26		40	56	35	10·4			

The brightness at the time of discovery is taken as unity.

The comet is situated in the constellation of Pegasus, and on the 22nd will form very nearly an isosceles triangle with β Pegasi and α Andromedæ, the comet then lying nearly midway between η Pegasi and σ Andromedæ.

GEOGRAPHICAL NOTES.

M. LOUIS LÓCZY, in his annual address to the Hungarian Geographical Society at the commencement of the current session, expressed surprise that scientific geography was so little appreciated in England. "It is sad to see," he said, "that, despite the efforts of the oldest of Geographical Societies, the great Universities of Oxford and Cambridge have not yet established chairs of geography, and that lectureships even have only been established with difficulty."

IN the Report of the Mississippi River Commission, the extent of the levees confining the river below Cape Girardeau (Missouri) is given as 1300 miles. During the high water of 1891, the levees gave way in five places, and the total length of the breaches made in the embankment was about one mile. By far the most serious gap was that at Ames Plantation, opposite New Orleans, which attained a width of 1665 feet, and a maximum discharge of about 91,000 cubic feet per second. It overflowed 2000 square miles, one-tenth being cultivated land. The cause of this crevasse was a badly constructed rice-flume, and as the great Nita crevasse of 1890 had a similar origin, the Commission has resolved to discountenance the use of such flood-gates in future. All of the crevasses of 1891 put together discharged less water than the Nita crevasse alone in the previous year, and it was only one out of about fifty breaks which occurred during the great floods.

A NEW map of Dahomey, on the scale of 1 : 500,000, has been prepared by M. A. L. d'Albeca, and published as a supplement to the new journal, *La Politique Coloniale.* All available data have been employed in its preparation, much being of course derived from itineraries unchecked by observation.

CAPTAIN GALLWEY, Vice-Consul for the Oil Rivers Protectorate, has succeeded in tracing a channel navigable for canoes through the deltaic swamps between Benin and Lagos, a distance of 160 miles.

THE *Proceedings* of the Royal Geographical Society for May contains a letter from Mr. Gilbert T. Carter, Governor of Lagos, describing a recent journey into the interior. From the summit of a hill near Ode Ondo he obtained a magnificent view to the south-east over a foreground of rocky forest-clad hills, backed by a fine range of mountains about twenty miles away, which have not previously been reported. The height of the most conspicuous summits is estimated to be from 5000 to 8000 feet above sea-level.

THE VARIATION OF TERRESTRIAL LATITUDES.

IN a letter addressed to M. R. Radau by M. Antoine d'Abbadie, which appears in the March number of the *Bulletin Astronomique*, the writer gives an interesting historical account of the work that has been done with regard to this question. As it contains also some suggestions for future work, the following *résumé* may be of service.

The author states that M. Fergola, the astronomer at Naples, may be looked upon as the one who first drew attention to this question. Of the earlier astronomers, Sir George Airy was led to the conclusion that the latitude was subject to a slight variation, and he published in 1854 and 1875 the greatest and least values for the co-latitude 38° 31′ 22″·16, and 38° 31′ 21″·35 respectively, obtained from observations of the pole. Many other results were obtained by him, which caused him to assign reasons for the fluctuations, but he deemed it wiser to publish the results at a time when the measurement by graduated circles was considered more concise.

One of the first causes to which these variations were attributed was refraction, and it was with the intention of settling this point that Airy undertook with his zenith telescope the measurements of the zenith distance of γ Draconis, as this star culminated near the zenith at Greenwich. M. Faye, towards the year 1846, found out the advantages of such an instrument as that used by Airy, and his installation was composed of three instruments, a zenith telescope, a mercury trough, and a nadir telescope, the last two of which provided a means of obtaining the true nadir point.

Porro, an Italian officer, adopted several of these improvements in his instrument: he added to his telescope a trough with a glass bottom, the plane surface of which was placed in a horizontal position, and reflected feebly the image of the central thread of the zenith telescope. By filling the trough with water, another image of the same wire was obtained, which remained visible during the transit of the star, and it was possible to take several measures of the distance between the star and image.

The next observer we find occupied in this research was Respighi, who, in the year 1872, published the nadir distances of several stars measured at Rome. The stars he observed were those which culminated so near the zenith that they could be seen in the telescope after reflection from mercury. From a series of seventy-seven observations, taken during five months of the year 1869, he observed the transits of two stars reflected at his nadir. During this interval he found a difference of 2″·07 between the greatest and least of his results.

In the method of Horrebow, the divided arc on his instrument gave a rough reading of the inclination of his telescope, while for greater precision he used the readings taken from a level fitted to the telescope.

M. d'Abbadie here condemns the use of levels altogether for really accurate work, and backs his opinion with facts which he has obtained from personal experience. He mentions that, as far back as 1837, he made a study of their accuracy, but the levels he used were not good ones. Later, after having purchased some from the best-known makers in Paris, Munich, London, and Hamburg, he repeated his experiments in a cellar in an old *château*, and he found that the results given were of a most unsatisfactory kind.

Admitting, then, that there was a variation in the latitude, it was not long before periods were established. Peters, in the year 1845, from observations at Pulkova, derived one of 303·9 days with a maximum on November 16, 1842. Mr. Nyrèn extended this to 305·6 days, with a maximum on December 13, 1867, while Mr. Downing, from ten years of observations made at Greenwich, deduced a period of 306·0 days, with a maximum on October 12, 1872. Leverrier, and Hough at Albany, also found variations that were confirmed at Abbadia.

M. d'Abbadie then refers to the variation of the true azimuth, which, as he says, did not escape the notice of Airy. In the year 1848 he estimated it as 4″ or 5″, while fifteen years later he extended it to 6″ or 7″. Of course, if the pole suffers any displacement, such as an increase in elevation, at its two elongations it will be displaced by the same amount, and the azimuths in these cases would be increased. The greatest displacement we have mentioned is 2″·07, but M. d'Abbadie says "that if, by hypothesis, the north pole of the earth be elevated by 7″ by approaching the actual zenith, the true azimuth will be diminished by those 7″ in a place situated at 6h. om. of west longitude, and increased by the same quantity at 6h. om. of east longitude." He then states how, if the pole was considered movable for places situated at opposite ends of a diameter of the earth, the values for the variation should be the same, but of opposite signs. To establish coincidences of this kind, it is suggested that observers in Asia and America should take their nadir readings at the same time as they are taken at Abbadia —that is, in the morning and evening at 6h. Paris mean time. The results Chandler obtained from his latitude observations indicated a minimum on September 1, 1884, and a maximum on May 1, 1885, with a difference of about 0″·7. By taking the 6 o'clock p.m. P.M.T. observations made at Abbadia, it was found that a maximum value was obtained on September 1, 1884, and a minimum on May 1, 1885, with a difference of 0″·74. Contemporary observations made at Berlin and Honolulu tended also to the same conclusion; but in spite of them M. d'Abbadie does not think it prudent to suppose a fluctuation of the earth's axis.

After referring to some sudden changes that this variation has undergone, he goes on to mention Darwin's, Wolf's, and Paschwitz's instruments that were constructed for the measurement of very small displacements. The last-named modified to a large extent Zöllner's horizontal balance, and added to it a mirror, obtaining in this way, by the employment of photography, a continuous series of curves.

Mr. Nobile, in his memoir of 1883, related that, in 1820, Brioschi believed in the small changes in the terrestrial latitudes, and admitted two possible variations, one secular and another periodic. He states, also, that Fergola, in 1871, supported this idea of Brioschi; and Peters, as well as Nyrèn and Gylden, confirmed this opinion. Euler and Legendre are also said to have concluded from theory such a variation, giving it a period of ten months.

Another memoir by M. Nobile, contains a discussion on the observations that were made with the object of determining the latitude of the Observatory at Capo di Monte, near Naples, and from these, together with some others, he deduced a tendency in the latitude to increase in the summer and decrease in the winter months.

It will be seen from the preceding summary that very little is definitely known as to the causes of this variation. From the observations just referred to, it seems that refraction would be the cause of such a variation, but as this is not borne out in other observations, new theories must be advanced. M. d'Abbadie, knowing the importance that is attached to the inquiries into the causes of these variations, before concluding his letter adds a few suggestions relative to a means of settling some of these points, and the following is the plan which he proposes should be adopted.

Three observers, A, B, and C, should be provided each with a good zenith telescope; and the same two stars, which it is proposed to use, should be observed by them. B and C should be as near as possible on the same parallel of latitude, so as to have identical refractions when measuring the declination on the meridian of the chosen stars. To insure greater accuracy in these declinations, he suggests that these stars should be observed at their elongations with a geodetical circle, the refraction in azimuth being zero, save in a few rare cases of lateral refraction. The three observers should "notify at once, in a continuous way, if possible, the varying movements of the nadir, and, in every case, these variations at the precise moment where A would observe on the meridian."

To further complete this plan, two other observers, at D and and E, might be added, the former situated at 6h. east, and the latter at 6h. west longitude, in the same relative positions as Paris is to Calcutta and Chicago. The position of E or D could be chosen in the austral hemisphere, in order to determine whether the variation of the nadir agrees with that which should be observed simultaneously in the opposite hemisphere. Still greater advantage would be gained if two other observers, situated at opposite points of the earth, were chosen to observe these phenomena at the same instant. By adopting this plan, a definite control would be had over the hypothesis that the fluctuation was due to the movement of the terrestrial axis, and if only this point could be settled, we should have advanced a considerable step in its solution.

We may mention here that quite recently Chandler has made the remarkable discovery that the earth's axis of rotation revolves round that of her maximum moment of inertia in a period of 427 days. This, as Prof. Newcomb says, seems at first to be quite contrary to the principles of dynamics, but, after having investigated the theory, he finds that it is in perfect harmony with the amount that the latitude varies, taking into account the elasticity of the earth itself and the mobility of the ocean. Radau's investigations were based on a 306-day period, but he showed that the observed discordances would have to be multiplied three times before they agreed with those obtained by theory.

W. J. L.

MAGNETIC VARIATIONS.[1]

IN this paper the author refers to the ordinary variations of the magnetic elements as observed at Greenwich; the annual progressive change; the diurnal variation—large in summer, small in winter, and also larger when sun-spots are numerous and smaller when sun-spots are few; the irregular magnetic disturbances and magnetic storms, and the accompanying earth currents; phenomena which are generally similar at other places.

He then invites attention more particularly to magnetic disturbances. Those at Greenwich may, after a calm period, arise gradually or commence with great suddenness. When sudden, the movement is simultaneous in all elements. The first indication may be a sharp, premonitory, simultaneous movement, followed after a time by general disturbance, or the movement may at once usher in the disturbance. These initial movements are not always great in magnitude, sometimes, indeed, small, but they have a very definite character, and frequently occur nearly instantaneously, as is shown in the character of the photographic traces.

It has been long known that magnetic disturbances occur at the same time over wide areas of the earth's surface, but the accidental comparison in past years of the times of commencement of one or two disturbances at Greenwich with the times at other places has led the author to suppose that the coincidence in time is much closer than had been before supposed, and the definite, and on occasions isolated, character of the initial movement induced him to undertake the collection and comparison of the times of such movements for a number of days at observatories geographically widely separated.

The times of such movements cannot be caught by eye observation without continuous watching of the magnets, so that the photographic registers have to be relied upon, which is better, excepting that the scale of time is necessarily contracted; but, though in individual measures there might be variations, it was conceived that (supposing no systematic error to exist) the mean of a number of comparisons should give a good result. Seventeen days, occurring in the years 1882 to 1889, were selected for comparison, the observatories being those of Toronto, Greenwich, Pawlowsk, Mauritius, Bombay, Batavia, Zi-ka-wei, and Melbourne, and, for a less number of days, Cape Horn (as obtained from the Mission Scientifique du Cap Horn, 1882–83). It was desired to have times for Pola, but it was found that photographic registers during great part of the period did not exist. The variation in time at each place from the mean of times for all places is given for each day. The mean deviation at the different places varies from + 2·4 minutes to − 2·9 minutes, the agreement between four of the places—Greenwich, Pawlowsk, Mauritius, and Bombay—being very much closer, the mean values of deviation for Greenwich, Pawlowsk, and Bombay differing, indeed, by only 0·1 minute, equivalent to 6 seconds.

The question arises, Are the differences real, or due (considering the contracted time scale) to accidental error? If the magnetic impulse is really simultaneous over the whole earth, it is a striking physical fact, and if not entirely so, the circumstance is no less interesting; but greater attention to accuracy of time scale, or a more extended scale, may be necessary before the point in question can be definitely settled.

A table is added, showing the character of the magnetic movement at the several observatories, from which it appears that at any one place the movements on different days were in most cases similar, though different at different places, indicating on these occasions the occurrence usually of one general type of disturbance.

Reference is made to the question of earth currents. A comparison for thirty-one days, between 1880 and 1891, of cases of sudden magnetic movement and earth current at Greenwich, shows the earth current to precede the magnetic movement by 0·14 minute, equivalent to 8 seconds. The question of the relation between magnetic movements and earth currents is discussed.

The desirability of being able temporarily to obtain, when occasion requires, a more extended time scale for all magnetical and meteorological phenomena is pointed out.

The general result is that in the definite magnetic movements preceding disturbance the magnets at any one place are simultaneously affected; also that in places widely different in geographical position the times are simultaneous, or nearly so, a small constant difference existing at some places which may be real or may be accidental, but the character of which it seems desirable to determine. It is shown also that at Greenwich definite magnetic movements are accompanied by earth current movements which are simultaneous, but that neither magnetic irregularities nor ordinary magnetic variations seem to admit of explanation on the supposition of being produced by the direct action of earth currents.

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[1] Abstract of paper "On the Simultaneity of Magnetic Variations at different places on occasions of Magnetic Disturbance, and on the relation between Magnetic and Earth Current Phenomena," by William Ellis, F.R.A.S., Superintendent of the Magnetical and Meteorological Department, Royal Observatory, Greenwich. Communicated to the Royal Society, on May 5, 1892, by W. H. M. Christie, F.R.S., Astronomer-Royal.

SCIENTIFIC SERIALS.

American Journal of Science, May.—Radiation of atmospheric air, by C. C. Hutchins. A stream of hot air was arranged so that it could be made to pass in front of one of the faces of a thermopile at a distance of 3 cm., and cause a deflection of a galvanometer needle, or the air could be discharged high above the thermopile, leaving it unaffected except by radiation from a large Leslie cube containing water at the temperature of the laboratory. There was no sort of agreement between measures made on eight different days to determine the absolute radiating power of a column of air 1 centimetre thick at a temperature near 100° C.; but in an ordinary room and under average conditions the value came out = 0·000001133 + 0·0000000711 $(t - t')$, where $t - t'$ is the difference in temperature between the air and the cube. Tyndall's result, that the radiation increases with the amount of moisture in the air, was confirmed, but no exact law of connection between the two was found. This is probably due to the presence of accidental impurities in the air employed. The increase of radiation proves to be proportional to the increase of temperature. There was a small increase of radiating power when sheets of air more than 1 centimetre thick were used; with sheets less than this thickness, no difference of radiation could be detected.—Atmospheric radiation of heat and its importance in meteorology, by Cleveland Abbe. In this interesting and exhaustive paper Prof. Abbe brings together practically all the conclusions that have been arrived at on atmospheric movements and their relation to radiation from the air. In his words, "A comprehensive study of fluid motions shows that air and water alike may be forced to ascend without being warmer and lighter, or to descend without being colder and denser, than the surrounding fluid. The currents and whirls behind any obstacle in streams of air or water are almost wholly independent of differences of density, and are caused by differences of pressure as modified by simple kinetic laws." These motions, which the air is forced to take for purely kinetic reasons, are specially discussed in detail, but it is impossible to enumerate, in an abstract, the many cases considered.—Experiments upon the constitution of certain micas and chlorites, by F. W. Clarke and E. A. Schneider. The minerals analyzed are waluewite, v. of xanthophyllite, clinochlore, leuchtenbergite, diallage, serpentine, and mica from Miask, Ural.—On the qualitative separation and detection of strontium and calcium by the action of amyl alcohol on the nitrates, by P. E. Browning.—The age and origin of the Lafayette formation, by Eugene W. Hilgard.—On the influence of swamp waters in the formation of the phosphate nodules of South Carolina, by Dr. Charles L. Reese. From the experiments it appears probable that both carbonic acid and the humus substances in fresh-water swamps play an important part both in the accumulation and the concentration of calcium phosphate, and thus in the formation of phosphate nodules, these being considered to be phosphatised marls.—Plattnerite, and its occurrence near Mullars, Idaho, by William S. Yeates; with crystallographic notes by Edward F. Ayres.—On the occurrence of Upper Silurian strata near Penobscot Bay, Maine, by William W. Dodge and Charles E. Beecher.—Zinc-bearing spring waters from Missouri, by W. F. Hillerbrand. The chief constituent salt in the spring in question is zinc sulphate. It forms about 56 per cent. of the total dissolved solids.—A meteorite from Central Pennsylvania, by Prof. W. G. Owens. A chemical analysis of the meteorite gave Fe 91·36, Ni 7·56, Co 0·70, P 0·09, S 0·06, Si trace = 99·77.—On two meteoric irons, by G. F. Kunz and E. Weinschenk. One of the masses examined came from Indian Valley Township, Floyd County, Virginia; the other from Sierra de la Ternera, Province of Atacama, Chili.—The molecular masses of dextrine and gum arabic as determined by their osmotic pressures, by C. E. Linebarger. The molecular mass of gum arabic is found to be about 2500, of dextrine 1134, and of colloid tungstic acid 1750. In each of these three cases the colloid molecule is seven times the simple molecule.

American Journal of Mathematics, vol. xiv., No. 2. (Baltimore, Johns Hopkins Press, April 1892.)—The number before us opens with a paper entitled "Some Theorems relating to Groups of Circles and Spheres," by Prof. W. Woolsey Johnson (pp. 97–114). The title at once calls to mind Mr. Lachlan's memoir "On Systems of Circles and Spheres" (Phil. Trans., vol. 177). The author thus puts the connection between the papers: "(1) If there be 5 circles or 6 spheres in each group, the product or determinant of powers is equal to zero; and (2) if there be 4 circles or spheres in each group, the power determinant is the product of two determinants each of which depends upon one of the groups." Mr. Lachlan's results are derived principally from the first of the above theorems, whereas it is Prof. Johnson's object "to point out some other results derivable from the second theorem, and particularly to evaluate the power determinants for groups of smaller numbers of circles and spheres." The two memoirs are an interesting application of a "Theorem in the Geometry of Position" (the multiplication of two determinants) due to Cayley (*Camb. Math. Journ.*, vol. ii., 1841).—The next paper, by C. H. Chapman, is an "Application of Quaternions to Projective Geometry" (pp. 115–40).—Then follows an adaptation of G. W. Hill's method (*American Journal of Mathematics*, vol. i.) "so as to include that class of inequalities which depends also on the ratio of the solar and lunar distances, and, in particular, the principal part of the parallactic inequality," by E. W. Brown. The title of the paper is "On the part of the Parallactic Inequalities in the Moon's Motion, which is a Function of the Mean Motions of the Sun and Moon" (pp. 141–60).—The two remaining papers were read before the New York Mathematical Society, viz. "On the Curves which are self-reciprocal in a Linear Nulsystem, and their Configurations in Space," by C. P. Steinmetz (pp. 161–86); and "A Classification of Logarithmic Systems," by Irving Stringham (pp. 187–94).—This last is an attempt to use the logarithmic spiral, defined as a geometrical locus, as the means for defining the logarithm and demonstrating its properties.

Bulletin of the New York Mathematical Society, vol. i. Nos. 6, 7 (New York: March, April, 1892).—The first of these numbers opens with a discussion of the mechanical axioms, or laws of motion, as presented by Newton. The author, Prof. W. Woolsey Johnson, examines at some length (pp. 129–39) the views put forward in Thomson and Tait, "Natural Philosophy"; Tait, "Mechanics" ("Encyc. Brit."); and Williamson and Tarleton, "Dynamics." The article is a careful piece of reasoning, founded upon the principle that "it is desirable to include among the axioms of mechanics the smallest basis of postulated principles upon which it is possible to construct the science by rigid mathematical reasoning." Then follow short notices of an 8-figure logarithm table, published "par ordre du Ministre de la Guerre, Paris, 1891," and of "An Introduction to Spherical and Practical Astronomy, by Dascom Greene (Boston, 1891)." The usual "Notes" and list of new publications close this number and also No. 7. This last-named number opens with a review of "The Laws of Motion, an Elementary Treatise on Dynamics, by W. H. Laverty." The writer's object in this, and similar articles that are to follow, is "by reviewing somewhat at length a few of the better recent works on elementary mechanics to 'fix the ideas' and arrive at some conclusions, at least, as to what is the best modern usage in treating the subject" (pp. 145–50). The next contribution, by Dr. C. H. Chapman, entitled "Weierstrass and Dedekind on General Complex Numbers" (pp. 150–56), is one of those that makes this *Bulletin* so interesting and valuable to the student. The last article is a translation (pp. 156–68) by Prof. Ziwet of an *éloge* by M. Duhem on "Emile Mathieu: His Life and Works."

Memoirs of the St. Petersburg Society of Naturalists, vol. xxi. (Section of Botany).—Besides the proceedings, the volume contains the first part of an excellent monograph, by M. Aggeenko, on the flora of Crimea, being a description of the botanical geography of the peninsula. The orography and hydrography of Crimea, and its various soils, are shortly described, as also its climate. The periodical phenomena of blooming and fruit-bearing are next dealt with. The following chapter is devoted to the analysis of previous exploration, and the remainder of the work is given to the description of the character of vegetation in the Steppes of Crimea, on the northern slope of the highlands, the flat summits of the Yaila highlands, and especially the southern slope. The influence of man and of the fauna on vegetation is briefly treated, and a new species, *Alyssum rotundatum*, as well as a new variety of Orchids (*Ophrys aranifera*, Hudson, var. *taurica*) are described and figured on plates. A very interesting geo-botanical map of Crimea is given.—A paper on the pigments of Fungi, by A. Nadson, must be rather considered as a preliminary communication, containing many valuable data on the pink, yellow, red, and orange pigments of some fifteen species.—On the crystals in the leaves of the *Anonaceæ* and *Violarieæ*, by Prof. Borodin.

Vol. xxii. (Section of Zoology and Physiology).—Ornithological observations in the middle course of the Amu-daria in the Tcharjui-kelif region, by A. Yaschenko. A list of 161 species of birds and their distribution in various regions (cultivated, mixed, deserts, and mountains) is given, each of the regions being described separately as to its most characteristic birds.—On the hybrids between *Butydes flava* and *Butydes campestris*, by N. Zaroudnoi. — On the embryonal development of *Phyllodromia* (*Blatta*) *Germanica*, by N. Kholodkovsky, being a very elaborate and valuable contribution to comparative embryology. It is the fruit of a four years' laborious research, and is accompanied by five large well-drawn plates.

Bulletin de l'Académie des Sciences de St. Pétersbourg, Nouvelle Série, t. ii., No. 3.—The ephemeris and the approximate elements of the comet of Encke for the year 1891, by O. Backlund (in German). The ephemeris is calculated from July 2 to November 1, 1891, after having taken into account the perturbing influences of Venus, the Earth, Mars, and Jupiter in 1884–88, and Jupiter alone from March 7, 1888, to May 31, 1891.—Additions to the Flora of the Caucasus: i. Two new varieties of *Rhamnus*, by N. Kuznetsoff (in German, with two plates).—On the radiants of the Andromedides, by Th. Bredikhine (in French), with a plate. The meteoric current of November 27, 1872, and 1885 is studied, the former on the ground of the observations of the Brera Observatory at Milan. The positions of the radiants are given on a map, upon which the orbit of the comet of Biela (for 1859) is also traced. The positions of the radiants being taken into account, the author compares the probable elements of the meteoric current with the orbit of the Biela comet. Taking further into account the meteoric currents observed on December 7 and 8 in 1798, 1830, 1838, and 1848, the author concludes that those currents must have belonged to the orbit of the same comet before the severe perturbations it suffered through the influence of Jupiter in 1794.—Observations of 51 double stars, followed by a research into systematic errors, by F. Renz, of Pulkova (in German). The observations and the catalogue based upon them are given.—On some old and new catalogues of stars, by J. Seyboth (in German). Before the printing of Romberg's catalogue a comparison of its data with those of previous catalogues was felt to be necessary. A series of comparative measurements has been undertaken for that purpose, and their results are given in the introduction to Romberg's catalogue. Further comparison is now made with the catalogues of Struve, Argelander, Pulkova (3542 stars), Becker, and Gould, and reduction tables are given.—A new Bacterium, *Nevskia ramosa*, by A. Famintzin (in German), with a plate. This strange organism, so widely different from all known Bacteria, but not unlike to Metchnikoff's *Pasteuria ramosa*, consists of a jelly-like ramified growth, the Bacteria cells appearing upon the ends of the branches. It forms colonies similar to those formed by some Algæ and Infusoria (*Urococcus*, *Gomphonema*, *Epistylis*).—On the libration of Hyperion, by H. Struve (in French). The last years' observations of this satellite of Saturn, which have been made with the aid of the great Pulkova refractor, having disclosed considerable discrepancies from the ephemerides calculated by Mr. Marth, the Pulkova astronomer tried to explain them—and succeeded to a great extent—by a libration which has a short period of 641 days, and an amplitude of 9° in the average longitude.—Revision of the Hymenopteres of the Zoological Museum of the Academy, by A. Semenoff: i. Genus *Cleptes* (in Latin). The following new species are described: *Cleptes flammifer*, *obsoletus*, *Buyssonis*, and *Mocsarii*; ii. Genus *Abia* (new species): *A. symballophthalma*.—New Gentianæ from Asia, by N. Kuznetsoff. The following new species, some of which had already been recog nized as new by Maximowicz, are described: *Gentiana Maximowiczi, leucomelæna, purpurata, siphonantha, Regeli, glomerata*, and *G. Kuroo*, var. *brevidens*. They are from Central Asia, North China, and Mongolia.—Report of the International Meteorological and Polar Conferences, and the International Committee of Weights and Measures, by H. Wild. No. 4: Remarks on Mr. Kock's work, "Comicorum Atticorum fragmenta" (in German).

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 5.—"Transmission of Sunlight through the Earth's Atmosphere. Part II. Scattering at Different Altitudes." By Captain W. de W. Abney, C.B., D.C.L., F.R.S.

In this paper the results of observations made by exposing platinotype paper are recorded, and it is shown that the total intensity of light as thus registered is the same as if observations had been made on a ray of λ 4240 alone. The observations were made at altitudes varying from sea-level to 12,000 feet in different countries, at different times of the year, and during four to five years. The instrument in which the exposures were made is described, as also the method of deriving the intensity of light from the developed prints. The results of these observations agree closely with those obtained by the measures of the spectrum which was described in Part I. of this subject. The value of k in the formula (1) $I' = \epsilon^{-k\lambda^{-4}x}$ (from which can be calculated the loss of intensity of a ray of any particular wave-length) was found to be 0·00146 at sea-level. It was also found that k apparently varied as h^2, h being the barometric pressure. A table is attached, showing the value of the transmitted light in the formula (2) $I' = Iax$, where a is a constant and x the air thickness in terms of the vertical thickness, μ being the formula $I' = I\epsilon^{-\mu x}$, from which (1) and (2) are both shown to be derived.

Bar in inches.	μ.	a.	Bar in inches.	μ.	a.
30	0·154	0·856	24	0·098	0·908
29	0·144	0·866	23	0·090	0·915
28	0·134	0·875	22	0·083	0·922
27	0·124	0·884	21	0·075	0·928
26	0·115	0·891	20	0·068	0·934
25	0·107	0·899	19	0·062	0·940

Linnean Society, April 21.—Prof. Stewart, President, in the chair.—An example of an Australian bird (*Gymnorhina*), which had lately been shot near Tor Abbey, Devonshire, after being observed all the winter, and which had doubtless escaped from confinement, was exhibited on behalf of Mr. W. Else, Curator of the Torquay Museum.—On behalf of Mr. Charles Head, of Scarborough, two specimens of the Whiskered Bat (*Vespertilio mystacinus*) taken in that neighbourhood were exhibited.—Mr. W. B. Hemsley, F.R.S., read a paper entitled "Observations on a Botanical Collection made by Mr. A. E. Pratt in Western China, with descriptions of some new Chinese plants from various collections." Mr. Pratt travelled in 1889–90 in Western China, close on the borders of Eastern Tibet, and though chiefly in search of zoological specimens, he fortunately secured the services of a native who had been trained to dry plants by Dr. Henry, the result being that he was enabled to bring home a very interesting botanical collection. The plants were obtained chiefly at elevations of 9000 to 13,500 feet, in the neighbourhood of Tat-sien-lu, a frontier town situated in about 30° N. lat. and 102° 15′ E. long.; and although Mr. Hemsley reported that he had not finished working out the collection, he estimated that it contained about 500 species, of which perhaps 150 species were new to science. The paper was criticized by Mr. C. B. Clarke, who remarked that the mountain ranges of Western China seemed to abound in showy herbaceous plants, rivalling in this respect the richest districts of the Himalayan region, of which, in fact, it is a continuation.—Mr. H. M. Bernard then gave an abstract of a paper on the relation of the Acaridæ to the Arachnida, in which he argued that the former were fixed larval forms of the latter; though he found a difficulty in dealing with the segmentation, this being so profoundly modified and in some cases lost. The paper was criticized by Mr. A. D. Michael, Mr. Breeze, and Prof. G. B. Howes, all of whom, while testifying to the ingenuity of Mr. Bernard's reasoning, considered that there was hardly as yet sufficient evidence to justify the acceptance of his conclusions.

May 5.—Prof. Stewart, President, in the chair.—On behalf of Mr. Holt, Prof. G. B. Howes exhibited and made remarks on a very interesting collection of the metamorphosing larvæ of flat-fish.—Mr. Curtis showed a photograph of sections of the Silver and Douglas firs, illustrating the relative rate of growth in trees of the same age growing in the same soil and under similar conditions in all respects, the diameter of the one (*A. Douglasii*) being nearly double that of the other.—Mr. George Murray exhibited spirit specimens of *Ascothamnion intricatum*, an organism described as a siphoneous Alga, but ascertained to be identical with an animal—namely, *Zoobotryon pellucidum*, Ehrenberg. He also exhibited two specimens of a palm (*Thrinax Morrisii*, Wright), peculiar to Anguilla in the Leeward Islands, and made some remarks as to the results of the recent cryptogamic collections made by Mr. W. R. Elliott for the West India Committee.—Mr. Holmes exhibited and made some observations on an abnormal development of the calyx in a primrose.—The President exhibited and explained a collection of Lepidoptera containing several examples of mimicry between protected forms.—On behalf of Dr. J. Müller, Mr. Thiselton Dyer communicated a paper entitled "Lichenes Epiphylli Spruceani."—Mr. W. F. Kirby gave an abstract of a paper on the family *Saturnidæ*, with descriptions of new species in the British Museum.—In the absence of the author, Mr. W. Percy Sladen read a paper by the Rev. Hilderic Friend, entitled "Observations on British Earthworms."—The President announced that the anniversary meeting of the Society would be held on May 24, at 3 p.m.

Royal Microscopical Society, April 20.—The President, Dr. R. Braithwaite, in the chair.—Mr. A. W. Bennett called attention to some slides received from Prof. D. P. Penhallow, of Montreal, who sent them to illustrate an improved method of labelling. Instead of writing upon the usual paper label, he writes directly upon the glass, and covers the writing afterwards with a thin coating of Canada balsam, which makes it permanent.—Prof. F. Jeffrey Bell said that, the Council having concluded the negotiations with their landlords, the rooms of the Society would now be open for the use of the Fellows every Wednesday evening from 6 to 10 p.m., from November till June. This order would take effect at once.—Mr. F. Chapman's paper onthe Foraminifera of the Gault of Folkestone was read.—Surgeon P. W. Bassett-Smith's paper on the deep-sea deposits of the Eastern Archipelago was read by Prof. Bell. H.M.S. *Penguin*, to which Surgeon Bassett-Smith was attached, made a passage during the latter part of 1891 from Port Darwin, North-west Australia, through the Arafora, Banda, Celebes, Sulu, and China seas to Hong Kong. A continuous and close line of soundings was taken through the whole passage, the deepest water being 2880 fathoms in the Banda Sea. In almost every instance specimens of the bottom were obtained. They consisted mostly of "green muds," with a few "blue" and "brown muds" in the deeper parts. The definition of "green mud" is a very wide one; broadly it may be divided into that in which calcareous organisms, chiefly Globigerina, predominate, and that in which the tests of Radiolarians have taken their place; this latter condition was almost always present in "brown muds." The inorganic materials were either fine quartz sand in the deeper and more distant positions, or, as the coast was approached, argillaceous matter together with sponge spicules and small shells. In places the material was typically volcanic, as in the upper part of the Banda Sea, among the Moluccas, and on the coast of Luzon. Only two specimens of pure Globigerina ooze were obtained, both being in the Molucca passage, one in 1885 fathoms and the other in 197 fathoms. It would seem that in the deeper parts of the seas the bottoms consist of Radiolarian muds, and the shallower parts of Globigerina muds, the line being roughly drawn at 1500 fathoms. In almost every case over 2000 fathoms the siliceous organisms were undoubtedly most abundant.—A note was read from Dr. E. Giltay on the use of the camera lucida in drawing Bacteria, in which he recommended the illumination of the drawing by a powerful lamp, and the testing of the drawing by a slight change in the position of the paper, so as to compare side by side the drawing made and the camera lucida outline. Dr. Giltay stated he had succeeded in drawing objects magnified 2500 times. Mr. A. D. Michael thought the method of comparison would be likely to produce distortion.—Prof. Bell said a note had been received from Mr. J. C. Wright on some rotifers which he had found attached to a newt. The accompanying drawings did not render it sufficiently clear that what he had found were really rotifers, and he suggested they were Vorticellæ. —A note from Mr. W. M. Osmond was also read, descriptive of a new cheap photomicrographic stand. Dr. W. H. Dallinger thought that though it might be useful for low-power work, he doubted if it would be of value for high or even moderate powers. He should be afraid that there would be too much vibration. Mr. C. L. Curties said he should be sorry to use it for anything beyond a half-inch objective.

Geological Society, April 27.—Prof. J. W. Judd, F.R.S., Vice-President, in the chair.—The Chairman announced that the Organizing Committee of the International Geological Congress have arranged to convene the sixth meeting of the Congress at Zürich, about the commencement of September 1894. Any communications should for the present be addressed to Prof. E. Renevier, University, Lausanne.—Prof. W. C. Williamson, F.R.S., exhibited the following specimens: slab of Carboniferous Limestone from Bolland, illustrating the passage of a foraminiferal ooze into crystalline calcite; *Asteropecten Orion*, Forbes, from the Kellaways rock, near Pickering, Yorkshire; and made the following remarks:—The specimen before me is a slab of Carboniferous Limestone from the Bolland district of West Yorkshire. In its centre is a magnificent section of a large Nautilus—beautiful as a fossil, but still more important because of what it teaches. Its large terminal chamber is filled with foraminiferal ooze, the component objects of which are almost as perfect as when the organisms were living. The surrounding limestone is chiefly in an amorphous state; but it contains innumerable evidences that it also consists of foraminiferal ooze, largely reduced to the amorphous state by the agency of carbonic acid, now known to be so abundant in the depths of the ocean. The action of this acid upon the minute calcareous shells necessarily converted the water into a solution of carbonate of lime. In this state it percolated by osmosis through the shell of the Nautilus, penetrating its closed chambers, which it gradually filled with calcareous spar. The specimen is thus an epitome, within its limited area, of what has taken place on a gigantic scale in the deep sea. We have here first the organic mass, next its conversion into amorphous limestone, and lastly the production of the crystalline state of the same, so frequently seen filling the interiors of fossils. The second object is the original type-specimen of Forbes's *Asteropecten Orion*, from a sandstone bed of the Kellaways rock in the neighbourhood of Pickering, in Yorkshire. This starfish had lived upon and became buried in a sandy matrix which contained no lime. When the rock was split open, the space originally occupied by the starfish was hollow; the sand contained no soluble material, like that which filled the chambers of the Nautilus. But in the lowest beds of the Coralline Oolite at Filey Brigg, on the Yorkshire coast, we long ago found another species of starfish closely allied to the Pickering species. This was embedded in calcareous stone, which had once in all probability been foraminiferal ooze, and the processes which filled the chambers of the Nautilus also filled the cavity left by the decay of the starfish with crystalline carbonate of lime. These specimens, studied collectively, illustrate two of the most important and common of the processes by which the mineralization of fossil remains has been effected.—The following communications were read:—Notes on the geology of the Northern Etbai or Eastern Desert of Egypt, with an account of the emerald mines, by Ernest A. Floyer. The principal feature in the district is a long ridge of igneous upthrust running north north-west and south-south-east, in which porphyry rises into lofty peaks, whilst the lower parts are formed of granites and sedimentary rocks. To the west of the watershed, sedimentary rocks occur dipping slightly to the west. The following succession of rocks in descending order is given by the author: limestone, sandstone, clay, "cataract"-rock (corresponding to the *Stock-granit* of Walther), and compact hard granite. The sedimentary rocks are frequently metamorphosed, and the author states that every stage of metamorphism is shown, from sandstone to compact green granite. The blue clay shows various kinds of metamorphism, and forms the pistachio-breccia containing topazes, and the mica-schist, mica-slate, and talcose blue clay of the mass of Zabbara containing emeralds. The author discusses certain theoretical questions, and considers that the erosion of the valleys does not indicate the existence of a greater rainfall than the present one. He concludes by giving an account of the emerald mines. The reading of this paper was followed by a discussion, in which Prof. Hull, Prof. Le Neve Foster, Mr. Rudler, Mr. J. W. Gregory, and Dr. Blanford took part.—The rise and fall of Lake Tanganyika, by Alex. Carson (communicated by R. Kidston). In this paper attention is called to certain recorded discrepancies concerning the discharge of Tanganyika by the Lukuja. It is suggested that the rise of the lake is due to the blocking-up of the river by vegetation, assisted by silting during the first rains, whilst the fall is produced by the destruction of the barrier formed in this manner.

Zoological Society, May 3.—Prof. W. H. Flower, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of April, 1892, and called attention to a finely-marked Owl (*Pseudoscops grammicus*) from Jamaica, presented by the Jamaica Institute, being the first example of this Owl that has reached the Society.—Mr. Sclater exhibited and made remarks on a fine specimen of the egg of *Æpyornis*, the extinct giant bird of Madagascar, obtained from Southern Madagascar, and brought to this country by Mr. Pickersgill, H.B.M. Vice-Consul at Antananarivo.—Mr. Oldfield Thomas read a paper on the probable identity of certain specimens formerly in the Lidth de Jeude collection, and now in the British Museum, with those figured by Albert Seba in his "Thesaurus" of 1734.—Mr. F. E. Beddard read some notes on various species of aquatic Oligochætous Worms that he had lately had an opportunity of examining. Amongst these was a new form allied to *Acanthodrilus* from the saline waters of the Pilcomayo, discovered by Mr. Graham Kerr during the Pilcomayo expedition.—Dr. Hans Gadow read a paper on the systematic position of *Notoryctes typhlops*, the newly-discovered Mammal of Central Australia, and came to the conclusion that this anomalous form should stand as a distinct family of Polyprotodont Marsupials, allied to the Dasyuridæ and the Peramelidæ.—A communication was read from Captain H. G. C. Swayne, R.E., containing field-notes on the Antelopes of Northern Somali-land. —Mr. W. Schaus read the second portion of his descriptions of new species of Lepidoptera Heterocera from Brazil, Mexico, and Peru.—Mr. W. L. Sclater read some notes on certain specimens of Frogs in the Indian Museum, Calcutta, and gave descriptions of several new species based upon some of these specimens.

Entomological Society, May 11.—Frederick DuCane Godman, F.R.S., President, in the chair.—The President announced the death, on May 4, of Dr. C. A. Dohrn, of Stettin, one of the ten Honorary Fellows of the Society. Mr. Stainton, F.R.S., expressed regret at the death of Dr. Dohrn, whom he had known for a great number of years, and commented upon his work and personal qualities.—Dr. D. Sharp, F.R.S., exhibited drawings of the eggs of a species of Hemiptera, in illustration of a paper read by him before the Society; and also a specimen of a mosquito from the Amazon district, with the body, legs, and palpi furnished with scales as in Micro-Lepidoptera.—The Rev. Canon Fowler, on behalf of Mrs. Venables, of Lincoln, exhibited cocoons of a species of *Bombyx* from Chota Nagpur, India; also the larvæ-cases of a species of Psychidæ, *Cholia crameri*, from Poona, India; and a curious case, apparently of another species of Psychidæ, from the island of Likoma, Lake Nyassa.—Mr. F. W. Frohawk, on behalf of the Hon. Walter Rothschild, exhibited a specimen of *Pseudacræa miraculosa* mimicking *Danais chrysippus*; also a specimen of the mimic of the latter —*Diadema misippus*—and read notes on the subject.—Mr. C. G. Barrett exhibited, and commented on, a long series of specimens of *Melitæa aurinia* (*artemis*) from Hampshire, Pembrokeshire, Cumberland, and other parts of the United Kingdom; also a long and varied series of *Coremia fluctuata*.—Mr. H. Goss exhibited, for Mr. W. Borrer, Jun., of Hurstpierpoint, a photograph of a portion of a nest of *Vespa vulgaris* which had been built with the object of concealing the entrance thereto and protecting the whole nest from observation. He also read notes on the subject, which had been communicated to him by Mr. Borrer.

—The Hon. Walter Rothschild communicated a paper entitled "Notes on a collection of Lepidoptera made by Mr. William Doherty in Southern Celebes during August and September, 1891." He also sent for examination the types of the new species described therein.—Dr. Sharp read a paper entitled "On the eggs of an Hemipterous Insect of the family *Reduviidæ*. Mr. McLachlan, F.R.S., Mr. Poulton, F.R.S., and Mr. Hampson made some remarks on the subject.

Mathematical Society, May 12.—Prof. Greenhill, F.R.S., President, in the chair.—The following communications were made:—A Newtonian fragment on centripetal forces, by Mr. W. W. Rouse Ball. The demonstrations given by Newton in his "Principia" are geometrical, though there is little doubt that in establishing the truth of some of his results he used fluxions (cf. the "Commercium Epistolium," Rigaud's "Essay on the first publication of the 'Principia,'" and Brewster's "Life of Newton"). To his contemporaries the language and methods of geometry were familiar, while to most of them the calculus was unknown; hence it was natural and reasonable that the proofs should be presented in a geometrical form. It is probable that the fluxional analysis by which a result was obtained was generally thrown aside as soon as a synthetic geometrical proof had been found; apparently the only proposition in the book of which Newton's fluxional demonstration has been published is his determination of the form of the solid of least resistance, of which the result alone was given in Book ii., Scholium to Prop. 35 (first edition). Among the numerous sheets of rough work and calculations which are preserved in the Portsmouth collection is a fragment on the law of centripetal force under which any orbit, and particularly a parabola of any order, can be described. The theorem to which the analysis leads is so inconvenient of application as to be practically useless, and probably for that reason was not inserted in the "Principia." Such interest as it possesses lies rather in its illustrating the way in which Newton arrived at the law given (in the paper) for the description of any parabola under a central force. The date of the fragment is put "about the year 1694," when we know that Newton was engaged in revising the first edition of the "Principia."—On an operator that produces all the covariants and invariants of any system of quantics, by Dr. W. E. Story.—Applications of a theory of permutations in circular procession to the theory of numbers, by Major MacMahon, F.R.S.

Oxford.

University Junior Scientific Club, March 18.—Mr. J. A. Gardner, Magdalen College, President, in the chair.—A paper was read by Mr. J. E. Marsh, Balliol College, on variations in the rotatory power of turpentine oil. This was chiefly given up to the consideration of the probable explanation of the phenomenon. The experiments were described at length in the Journal of the Chemical Society some months back.—Mr. T. H. Butler, of Corpus Christi College, read a paper on poisons, chiefly in relation to their physiological action.—Mr. H. Balfour, of Trinity College, exhibited a whaling cross-bow from Greenland.—Mr. F. Britten, of Christ Church, exhibited a specimen of incrustation.

March 30.—Mr. J. A. Gardner, President, in the chair.—Mr. E. B. Poulton, F.R.S., read a paper on a further investigation of the degenerate scales of Lepidoptera with transparent wings, which was illustrated by the magic lantern.—Mr. O. V. Darbishire, Balliol College, read a note on karyokinesis, illustrated by microscopical preparations.—A note was read by Mr. R. S. Hughes, Jesus College, on the action of dried hydrogen sulphide on magnesia.

Dublin.

Royal Dublin Society, April 20.—Sir Robert Ball, F.R.S., in the chair.—The following communications were made:—On a new mercury-glycerine barometer, by Dr. J. Joly. This barometer has the full range of the glycerine barometer. The total length of the tube is, however, only 250 cms. about. This result is attained by weighting the glycerine in the tube by a column of mercury 67 cms. in length. By means of a float in the mercury which pulls a disk, loosely fitting the tube, against the base of the column, this is kept from breaking, and falling down through the glycerine. In a uniform tube this column remains of invariable length and moves up and down with the glycerine. The balance of the atmospheric pressure is equilibrated by glycerine drawn from a bath of glycerine. Owing to the short length of tubing traversed by the viscous liquid, the instrument is probably more prompt than the full length glycerine barometer. On the other hand, there appears to be a very slow ascent of the glycerine past the mercury, which will probably necessitate the resetting of the instrument at intervals.—Mr. J. R. Wigham read a paper explanatory of the new "giant" lighthouse lens, the largest ever made, which he exhibited to the meeting. It was constructed for him by Messrs. Barbier and Co., of Paris. Its focal distance is 2 metres, and its axial intensity equal to 800,000 candles. The beam which this lens, in triform, in conjunction with Mr. Wigham's new "intensity" burner, is capable of transmitting to the mariner, has more than five times the power of that of Tory Island, the largest lighthouse light in the world, and is much more efficacious in penetrating fog than the most powerful electric light. —Dr. G. Johnstone Stoney, F.R.S., read a paper on the cause of the absence of hydrogen from the earth's atmosphere, and of water and air from the moon. In this communication reference is made to the conditions that determine the height of an atmosphere upon any celestial body. These had been announced by the author in a paper "On the Physical Constitution of the Sun and Stars," printed in the Proceedings of the Royal Society for 1868; and in the present paper it is pointed out that the same method of investigation shows that under certain circumstances some of the constituents of an atmosphere may, molecule by molecule, wander off into space. This event occurs with more readiness—(1) the lower the mass of the molecules of the gas; (2) the feebler the attraction downwards at the boundary of the atmosphere; (3) the higher the temperature at the boundary of the atmosphere. By investigating the conditions that prevail on the earth and moon, it is shown that free hydrogen could not remain a constituent of the earth's atmosphere; and that no free oxygen, nitrogen, or the vapour of water, could remain on the moon. Hence, even if there were no oxygen present, the earth's atmosphere could not retain free hydrogen; and on the moon there is now neither atmosphere, such as we know it, nor water, nor ice. It follows from the investigation that space must be peopled with vast numbers of wandering gaseous molecules, especially of the lighter gases, and that these tend ultimately to settle down upon such of the more massive bodies of the universe as are sufficiently dense to exercise a powerful attraction at their surface. Finally, the investigation indicates conditions which must be fulfilled by any "nebular hypothesis" in order that it may be admissible.—A list of Irish Rotifers, with descriptions of twenty-five new species, by Miss Glascott, was communicated by Prof. A. C. Haddon.

Paris.

Academy of Sciences, May 9.—M. d'Abbadie in the chair.—Photographs of solar prominences taken by M. Deslandres at Paris Observatory, by M. Mouchez. This is a brief statement of the work that is being done at Paris on the dimensions and velocities of solar prominences. By the methods employed the radial velocity can be determined within about a kilometre per second. Some of the photographs obtained were presented by M. l'Amiral Mouchez to the Academy. It is proposed to make a continuous record of the movements of the solar atmosphere as soon as the necessary funds are obtained.—On the propagation of Hertz oscillations, by M. H. Poincaré.—On residual life and the products of the action of separate tissues of living beings, by MM. A. Gautier and L. Landi. After a healthy animal has been killed, a considerable interval elapses before the death of the tissues. This action after the death of the body as a whole is termed "*la vie residuelle*" by the authors. They have investigated the changes that go on by analyzing flesh freshly killed and otherwise, and comparing the results.—On entire functions of the form $e^{G(x)}$, by M. Hadamard.—A theorem on harmonic functions, by M. G. D. d'Arone.—On the determination of the moment of the torsion couple of a unifilar suspension, by M. C. Limb.—Action of potassium cyanide on ammoniacal copper chloride, by M. E. Fleurent. By heating together in sealed tubes potassium cyanide, cupric chloride, and ammonium chloride, the author has succeeded in forming the compounds, (1) $2Cu_2Cy_2 . AmCy . 2NH_3 . 3H_2O$, forming long blue needles, very unstable; (2) $2CuCy_2 . Cu_2Cy_2 . 2NH_3 . 3H_2O$, green rectangular plates, quite stable in the air.—Sodium trimethylcarbinol:

thermal value of the replacement of H by Na in a tertiary alcohol, by M. de Forcrand.

$C_4H_{10}O$ sol. + Na sol. = H gas + C_4H_9ONa sol. . . . +27·89 cal.

For secondary and primary alcohols the values are respectively +29·75 and +32·00 cal.—Establishment of the fundamental formulæ for the calculation of maximum moments of inertia (of molecules), by M. G. Hinrichs.—The constitution of the hydrocarbon derived from perseïte, by M. L. Maquenne.—The chemical properties and analysis of acetyl fluoride, by M. Maurice Meslans. (See Notes.)—The acid antimonite of pyrocatechol, by M. H. Causse.—Action of organic acids on acetylenic hydrocarbons, by MM. A. Béhal and A. Desgrez.—On the stranding of a whale mentioned in the 113th Olympiad, by M. G. Pouchet.—On the physiological constitution of the tubercles of potatoes in relation to the development of shoots, by M. A. Prunet.—On the old glaciers of the Cordilleras of Chili, by M. A. G. Nogués.—On the genus *Megapleuron*, by M. Léon Vaillant.—On a Dicotyledon found in the Upper Cretaceous on the environs of Sainte-Menehould (Marne), by M. P. Fliche.

AMSTERDAM.

Royal Academy of Sciences. April 29.—Prof. van de Sande Bakhuyzen in the chair.—Mr. Behrens dealt with the microscopic structure of alloys. Crystallization is a common phenomenon in metals. The least crystalline are pure Al, Cu, Ni, when cast without overheating. Rapid cooling has no other effect than to make the crystals of smaller size. Pure Ag does show always crystallization, if properly etched. In alloys crystallization is more easy and perfect than in unalloyed metals. When 1 gr. of Cu, alloyed with 2 mgr. Ag, is melted and slowly cooled, it will be found chequered by minute threads of an alloy rich in silver. All types of structure found in crystalline rocks can be reproduced in alloys. The most common is rectangular wickerwork, less common are isolated clusters of crystals (alloys with few crystals of high melting-point, as in Zn + 10 per cent. Pt, Cu + 10 per cent. Co). Mechanical stress does not destroy the crystalline structure. A fibrous or lamellar structure is set up, corresponding with planes of sliding or shearing in intercrystalline matter, and under heavy stresses partly due to flattening and stretching of crystals. By annealing, alloys of Cu with Ni can be made to crystallize even as soft iron, thereby becoming even brittle.—Mr. Schoute treated of movement in space of *n* dimensions.—Mr. Bakhuis Roozeboom treated of the hydrates of iron perchloride.—Mr. Kapteyn made a communication on the distribution of the stars in space. He has compared the spectral type of stars of different proper motion. For this latter element the list given by Mr. Stumpe in the *Astr. Nachr.*, Nos. 2999–3000, was used; the spectral types were taken from Mr. Pickering's "Draper Catalogue." 476 stars not fainter than 7·0m. were found common to the two catalogues. Together with these, 115 other well-determined stars were used, taken from Bradley's catalogue, whose proper motion according to Auwers's reduction is less than 0·003s. in R.A., and less than 0″·03 in Decl. This material, arranged according to the amount of the proper motion, leads to the following conclusion:—The region of the universe nearest to our planetary system contains nearly exclusively stars of the second type (Pickering's Cl. E–L); with growing distances the number of stars of the first type (Pickering's Cl. A–D), relatively to the number of those of the second type, increases gradually and approximately in inverse ratio with the proper motion (*i.e.* very probably in direct ratio with the distance) in such a way that equality of number is reached at a distance corresponding to a proper motion of 0″·08 or thereabout. At distances still greater, the stars of the first type begin to preponderate, and they are more than twice as numerous as those of the second type at the mean distance of those of Bradley's stars, whose proper motion is insensible. From the differences between visual and photographic magnitudes Mr. Kapteyn shows that analogous results will most probably be found for the southern hemisphere as soon as a catalogue of southern star spectra is published. The investigation further indicates, though far less clearly, for the centre of symmetry of the system, a situation at a certain distance from the sun in the direction of 23 hours of R.A. Lastly, it is demonstrated that, even for distances corresponding to proper motion of 0″·16 to 0″·30, no accumulation of stars towards the plane of the Milky Way is shown; that for distances considerably greater this accumulation cannot be considerable, and that the Milky Way must be attributed therefore to stars at enormous distances.—Mr. Franchimont communicated an experiment used by him in his College during several years to show that the presence of hydriodic acid is necessary for the formation of iodine starch.

GOTTINGEN.

Royal Society of Sciences.—The following papers of scientific interest have appeared in the *Nachrichten* since November 11, 1891:—

November 11, 1891.—E. Riecke and W. Voigt, the piezo-electric constants of quartz and tourmaline.

November 25.—Franz Meyer, on a persistence-theorem for algebraic equations. Starting from the theorem that, for a cubic equation, the sum of the number of real roots for the cubic and its Hessian together is always three, the author finds for any equation of odd order a series of forms such that the sum of the real roots of the equation and these forms together is always the same.—Otto Bürger, preliminary communication on the *Nemertina* of the Gulf of Naples.—Otto Wallach, on certain new hydrocarbons with a ring of carbon-atoms.

December 23.—Alfonso Sella, contribution to our knowledge of the specific heats of minerals.—Frobenius, on potential functions whose Hessian is zero.—Schönflies, remark on Hilbert's theory of algebraic forms.—Alberto Tonelli, remark on the solution of quadratic congruences.—P. Drude and W. Nernst, on fluorescence-effects of stationary light-waves.

January 27, 1892.—Heinrich Burkhardt, the reduction of the twenty-seven lines of a cubic surface to the transformation problem of the hyper-elliptic functions for $p = 2$.—David Hilbert, on the theory of algebraic invariants.—Clemens Hartlaub, on the *Anthomedusæ*.

March 9.—J. Disse, changes in the renal epithelium during secretion.—Kroeker, the dependence of the specific heat of boracite upon the temperature.

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THURSDAY, MAY 26, 1892.

MATHEMATICS USED IN PHYSICS.

Einleitung in die Theoretische Physik. Von Victor von Lange. Second Edition, Enlarged and Revised. (Braunschweig: Vieweg, 1891.)

THIS work is intended to give an account of the mathematical processes employed in physical investigations. It is divided into chapters dealing with the various branches of physics, mechanics, gravitation, magnetism, electricity, solids, fluids, gases, light, and heat. It is very difficult in such a book to decide how far to go in mathematical processes, and Herr von Lange has exercised his discretion wisely in this matter. At the other limit of how little to assume known he has certainly not erred in the direction of assuming too much, for he introduces proofs of simple differentiations and integrations when he requires them, which had much better be learnt continuously in an elementary treatise on the calculus. No English student would use a book of this advanced character without some preliminary mathematical training, and it is very doubtful whether anybody picking up the calculus in this haphazard fashion could ever use it in his own investigations; and if it is no use to him for this, would it not be a great saving of time and energy for him to depend on the investigations of others without going through all their work, just as an investigator of magnetic declination need hardly expect to have time to work through the lunar and planetary theories that help in the calculations of the *Nautical Almanac* he uses? A work of this kind is of great service as a concentrated store of information for those who want to study physics, and who have sufficient mathematical ability and training to be able to use the mathematical processes involved; but it cannot successfully compete with special treatises on the elements of solid geometry, differential calculus, &c., as a means of supplying the mathematical training required in order to use these processes.

Some readers may be disposed to doubt whether it is worth while introducing into a work of the scope of this book any elementary dynamics. The subject, however, wastes only a few pages, and it may very well be worth while introducing it in order to avoid references and explanations that might be quite as long. His discussion of the nature of mass is hardly satisfactory without a description of apparatus and methods of experimenting, but, so far as it goes, is fairly sound. He does not point out with sufficient clearness where definition ends and observation comes in. These are, however, really physical questions, with which a mathematical work might very well dispense. In discussing the rotation of a solid subject to forces, he bases his investigation on Airy's mathematical tracts, but he does not safeguard himself with all the provisos Airy so carefully introduces; and in consequence there are many pitfalls, carefully hidden. The method is based upon supposing the body given a series of blows, and appears on the face of it to be purely kinematical. It is on the other hand evident that, in general, dynamical questions, such as the centrifugal acceleration introduced when the axis of rotation is not a principal one, must come into consideration when discussing the forces that must be applied to a real body in order to make it move in a given way. A student of this investigation would be puzzled to understand how it happens that a solid sphere, when rotating round an axis and given a blow, begins to rotate round a new axis, new both inside the sphere, and in space, while a gyroscope takes up a wobble. It is possible by a series of blows given to a sphere to cause its axis of rotation to move round in space while preserving its position in the sphere, but a series of blows in general would not produce this result. The kinematic investigation of rotation of a solid round an axis accompanied by an angular acceleration round a rectangular axis is an interesting geometrical question, but must be carefully distinguished from the dynamical question of what forces must be applied to a real solid in order to produce this motion, and these two different questions not being sufficiently clearly distinguished make the investigation unsatisfactory. In connection with the motion of a solid, it is to be regretted that a short account of the theory of screws was not included.

Under gravitation at one place, there is a full account of free fall, pendulums, balances, bifilar suspensions, torsion balance, &c. Then he proceeds to questions depending on gravitation at different places, the figure of the earth, the constant of gravitation. Here he mentions Foucault's pendulum, and notices that the elementary investigation is insufficient, without, however, giving more than the result of the complete investigation, not even explaining why the elementary investigation fails, owing to the precessional motion of the axes of the ellipse in which the bob of the pendulum necessarily moves, and which becomes comparable with the motion looked for, unless the amplitude be very small and the suspending thread very long. This chapter concludes with an account of the theorems connected with forces varying inversely as the square of the distance. It is doubtful whether it would not have been better to deal with this subject in the first place from the hydrodynamical point of view. Such theorems as that the flow is equal across every section of a tube of flow, and its numerous consequences, such as that equal quantities of electricity exist at the ends of a tube of force, that the total normal force over any surface is equal to 4π times the quantity of electricity within, &c., are all intuitively evident in hydrodynamics, and it is well to call a student's attention to the way in which he can safely argue from the familiar to the unfamiliar.

The chapter on magnetism is very complete, though the action of two magnets on one another is done in a fearfully long-winded way; and in the account of the determination of magnetic declination the spherical trigonometry required in order to calculate the azimuth of the terrestrial meridian from the astronomical observations is not given. It would also appear as if the determination of variations of dip by means of an induction vertical force magnetometer were quite a different thing from determinations of the variation of vertical force by means of a balance magnetometer. Magnetic induction is the usual mathematical investigation of simple cases where the permeability is assumed constant. An edition dated 1891 might have included some of the mathematics of hysteresis.

Electrostatics is treated as fully as it should be, though perhaps a single chapter on the law of the inverse square, containing most of the theorems required in magnetism and electricity, would have given a sounder view of the mathematics involved. It was hardly to be expected that a mathematician should avoid the temptation of describing Mossotti's theory of dielectrics without a warning that it can hardly be complete, and in consequence gives the electrical displacement as

$$\frac{K-1}{4\pi}$$

instead of $\frac{K}{4\pi}$ times the electrical force, thus making the displacement zero in a vacuum, and justifying this by saying that the results differ very little, while it would really overturn the whole electro-magnetic theory of light. This same overturning is calmly got over when the electro-magnetic theory of light is considered further on by a reference to this place, and this very remarkable statement that $K-1$ differs but little from K. There seems to be some confusion, arising from the fact that in electro-magnetic measure K is nearly 10^{21}, but such a muddle is inexcusable. He further on gives the theory of penetration of electric force into conductors, without referring back to an investigation he has previously given of the concentration of alternating currents on the surface of a wire, not appearing to appreciate that they are the same. He also actually explains wave propagation in dielectrics by induction from layer to layer because the inducing force is *very small* initially at a distance. He has not learnt the A B C of action by means of a medium, but is still hampered by the dry bones of theories of action at a distance. In consequence of this, his investigation of the magnetic action of electric currents is all bristling with the action of elements upon one another, and little or no attention given to the energy stored in the medium, or how it goes from place to place.

The chapter on solids begins with some rather doubtful physical paragraphs that are out of place in a mathematical work. Is it sound to call heat a force (*Kraft*) that holds the particles of bodies asunder? Is it sound to say that the difference between solids and liquids is the difficulty of separating the parts of the former, when it is known that it often takes hundreds of pounds per square inch to separate the parts of a liquid from one another, and when it is the resistance of the material to shear that he really uses as the characteristic of solids? That mistake of making the difficulty of separation and not the difficulty of shearing the characteristic of solids seems quite common: it occurs in many books. The mathematical theory of elasticity is given in the usual analytical way, and applied to some of the simpler cases of bending, &c. Periodic motion is then introduced, and the more important cases of wave motion and vibrations of solids considered. In the consideration of torsion he omits to give any warning as to difficulties arising in the case of non-cylindrical prisms. The chapter concludes with an investigation of the impacts of solid spheres in a manner that brings it into connection with the kinetic theory of gases.

The chapters on liquids and gases are fairly complete. There is an interesting numerical calculation of the height of a statical tide: this is an example of how complete and varied are the physical questions of which the mathematics is given by Herr von Lange. The elementary kinetic theory of gases is given, but without any discussion of the distribution of velocities amongst the molecules. Van der Waals's modification of the simple gaseous laws is discussed, and along with it the theory of cubic equations is given in a rather skimpy form—an example of how difficult it is to teach the higher physical mathematics in a way that applies to the particular case in hand, except by teaching the part of the higher mathematics involved from a wider point of view than the particular solution requires.

The chapter on light is hardly so full as such an important subject demands. Diffraction is run through, but the absence of bands inside a shadow is not discussed, and the theory of definition in telescopes is separated from the same question in microscopes in a very unscientific way. There is a lot of reflection theory, and a paragraph on the direction of the vibration relative to the plane of polarization; but no notice is taken of the theory of the blue sky, nor of the electro-magnetic method of determination, nor of Wiener's proof that it is the electric force which acts on silver salts, and is consequently the one probably effective in most chemical actions, and therefore in irritating the retina. It is possible, however that iron salts may be acted on by the magnetic force.

The last chapter is on conduction of heat and on the mechanical theory of heat. The first part is an account of the simpler parts of Fourier, as any book on conduction of heat must be, and the latter is a good account of thermodynamics. It is to be regretted that he does not give some mechanical illustrations of temperature, though a discussion of the nature of temperature would have been out of place. The chapter concludes with a variety of applications of thermodynamics to such questions as the relations of electromotive force, compressibility, and surface tension, to temperature, as well as the usual one, vapour pressure. It is much easier to point out defects than adequately to describe excellences. It must not therefore be concluded from the fact that much of this review is concerned with the former that the defects preponderate over the excellences of Herr von Lange's work. On the contrary, the work is full of excellences. The way in which physics and mathematics are tending to grow each purer—one in the direction of mathematical abstractions, complexes, matrices, and such like; the other in the direction of experimental methods, accuracy, phenomena, and such like—makes it daily more important for physical investigators especially to have by them a convenient *résumé* of those parts of mathematics that are most often useful to them in their investigations, and this has been ably supplied by Herr von Lange.

PHASES OF ANIMAL LIFE.

Phases of Animal Life, Past and Present. By R. Lydekker, B.A. (Cantab.). (London: Longmans and Co., 1892.)

THE sixteen essays which make up the volume are reprints, with a few alterations, of articles originally published in *Knowledge.* "They are intended," the author tells us, "to illustrate in a popular manner a few of the various modes in which animals—especially vertebrates—are adapted to similar conditions; and also to demonstrate some of the more remarkable types of structure obtaining among the higher vertebrates."

The subject is one upon which Mr. Lydekker is well qualified to write; this is alone a decided recommendation to the book. As a rule, the writing of "popular" books and magazine articles is done by persons who have no special knowledge of the matters of which they treat, and the result of this is not at all gratifying to instructed readers. Mr. Lydekker recognizes the fact that it is impossible to write upon zoology without using plenty of technical terms. When such terms are used they are introduced without any apologies. There are some authors who have the habit of invariably interpolating an apologetic remark in brackets whenever an unusually lengthy word is used. This practice is not at all humorous; and, besides, it is insulting to the intelligence of the reader. Anyone who is likely to read an article upon zoology is perfectly well able to take care of himself when he meets with a strictly technical explanation of some fact. Mr. Lydekker is therefore, in our opinion, quite right in speaking of "Condyles," "Dinosaurs," "Iguanodons," &c., with perfect freedom. Sometimes, however, he goes out of his way to invent or borrow an English equivalent for a scientific name; thus the Ichthyosaurus is always referred to as a "fish-lizard." It seems to us that if there be any fossil creature whose name is absolutely without need of translation it is the Ichthyosaurus; we cannot remember the time when this name was unfamiliar to us; besides, to speak of these reptiles as "fish-lizards" implies that they are intermediate between fishes and lizards, which is by no means the case. It would have been in every way much more reasonable if Mr. Lydekker had spoken of the Dinosaurs as "bird-lizards."

The chapter dealing with these same Dinosaurs is perhaps the most interesting. The information which is given must be newer to the general reader. There is a figure of one of the splendid skeletons of the Iguanodon recently unearthed in Belgium, and now on view in the Brussels Museum; the reproduction of the plate illustrating M. Dollo's memoir upon these remains is not, however, very good; it is difficult to distinguish the numerous small bones which lie along the vertebral column, and which are an indication of the immense development of the tendons of the muscles used to move the powerful tail of the reptile. M. Dollo thought that the Iguanodon lived principally in marshes swimming with the aid of the tail, and only occasionally coming forth to browse upon shrubs on the dry land.

There is naturally a chapter upon the Monotremes. Quite close to the beginning of the chapter it is stated that "within the last few years" these Mammals have been discovered to be oviparous, like reptiles and birds. Mr. Lydekker's book deals mainly with extinct forms of life, and he must have forgotten that in this chapter he was dealing with historical and not with geological time. It is surely unnecessary to remind the author that the oviparity of the Monotremata is not a discovery of the last few years; the *re*-discovery by Mr. Caldwell of this remarkable fact strikingly shows how an important point of this kind may be utterly forgotten. The history of the whole question has been the subject of an interesting article in this journal by Prof. Baldwin Spencer, which appeared two or three years ago.

F. E. B.

OUR BOOK SHELF.

Silk Dyeing, Printing, and Finishing. By George H. Hurst, F.C.S. (London: George Bell and Sons, 1892.)

PUBLISHED information connected with the application of colouring matters to silk is somewhat limited, and for the most part scattered throughout the various pamphlets issued by coal-tar colour manufacturers, the periodicals devoted to dyeing, &c.

The present publication is therefore very acceptable, since it brings together, in a convenient and useful form, much of this diffused information, and constitutes one of the well-known series of technological hand-books edited by Sir H. Trueman Wood, Secretary of the Society of Arts.

The author, Mr. Hurst, has here rewritten and brought up to date his articles on the subject of silk-dyeing which appeared during 1889 in the pages of the *Dyer and Calico Printer*, and has added chapters on silk printing and finishing, and on the testing of dyed silks.

The language and style of the book are clear and explicit, and it has evidently been written with distinctly practical aims, so numerous are the working details given throughout the work.

The opening chapter contains an account of the origin, structure, composition, and properties of the most important varieties of silk, followed by one on the preliminary operations of "boiling-off" and bleaching. Special chapters are devoted to the dyeing of blacks, fancy colours, and mixed fabrics. The concluding chapters deal with silk printing, the machinery used in dyeing and finishing, and the examination and assaying of raw and dyed silk.

Some 170 selected and also original recipes, together with 66 dyed patterns of yarn and cloth, appear as an appendix. Altogether the author has succeeded in compressing into a somewhat limited space of about 230 pages, a considerable amount of useful practical information.

In the body of the work, containing numerous technical details of dyeing, explanations of the principles underlying the different processes involved are here and there interspersed, so that the volume may be recommended as a handy book of reference not only for the practical dyer and his apprentice, but also for the student and teacher in technical schools where silk dyeing is taught.

Phycological Memoirs. Edited by Geo. Murray, F.R.S.E., F.L.S. Part I. (London: Dulau and Co., 1892.)

THE establishment of this new serial is an indication of the increased attention given in this country during recent years to the study of Algæ, whether marine or fresh-water. It is intended to form a medium for the publication of the results of researches on Algæ carried on in the Department of Botany at the British Museum, and for making known the treasures of the Museum; and the present number is full of promise of valuable additions to our phycological literature. The place of honour is given to a paper by Miss Margaret O. Mitchell and Miss Frances G. Whitting on *Splachnidium rugosum*, a well-known seaweed of the Southern Seas, hitherto included under the *Fucaceæ*, but which the authors regard as a new type of Algæ occupying possibly an intermediate position between the *Fucaceæ* and the *Laminariaceæ*. For reasons which certainly seem cogent, they are of opinion that the reproductive organs contained in the conceptacles are not sexual oogones and antherids homologous to those of the Fucaceæ, but non-sexual sporanges containing zoospores similar to those of the *Laminariaceæ*. Mr. E. A. L. Batters describes an interesting new genus of perforating marine Algæ, *Conchocelis*, belonging to the order *Porphyraceæ*, which forms pink stains on empty shells, especially those of *Mya truncata* and *Solen vagina*. Miss Ethel S. Barton describes malformations produced in two seaweeds, *Ascophyllum nodosum* and *Desmarestia aculeata*, by the attacks respectively of a new species of Nematode, *Tylenchus fucicolus*, somewhat similar to that which produces the well-known "galls" of *Vaucheria*, and of an undetermined Copepod. The editor himself has two papers, one on a fossil Alga belonging to the genus *Caulerpa*, from the Oolite (Kimmeridge clay of Dorsetshire), a new species, which he names *C. Carruthersii*; and one on the genus of marine Algæ, *Dictyosphæria*, the position of which he retains among the *Valoniaceæ*, near to *Valonia* and *Anadyomene*. The present number is illustrated by eight well-executed plates, most of them coloured. A. W. B.

Live Stock. By Prof. Wrightson. (London: Cassell, 1892.)

THIS is the third of Cassell's series of agricultural text-books, and though hardly equal to other writings of Prof. Wrightson, will be found useful as a reader in elementary classes.

The illustrations are well done, and the text is pretty clear, except perhaps on pp. 52–53, in a paragraph upon the "effect of food on milk." Here it is said that

"The quantity of milk is therefore in some degree dependent on liberal feeding. The quality of the milk is much less easily controlled, and it is doubtful if any special feeding will materially alter the percentage of butter-fats or cream in milk."

Then, at the end of the paragraph we have—

"Watery foods, such as silage, grass, grains, and distillery wash, increase the quantity of milk, but lower the quality, and in town dairies, where a large amount of milk is the principal object, they are much employed."

This paragraph is contradictory and confusing, for Prof. Wrightson himself admits that the quality of milk may be lowered by using watery foods, and we are decidedly of opinion that it may be increased by means of rich, oily foods.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Lord Kelvin's Test Case on the Maxwell-Boltzmann Law.

IN his recent communication to the Royal Society, of a case disproving the Boltzmann law, Lord Kelvin seems to have overlooked an important consideration.

It is well known that in an atmosphere near the earth, under conductive (not convective) equilibrium of temperature, the mean kinetic energy (*i.e.*, the temperature) would be uniform notwithstanding the attraction of the earth, which causes each molecule to move more rapidly at the lower end of its path than at the upper end. This is due to the effect of gravity in sifting out the less rapidly moving particles, preventing them from reaching the upper layers, so that, of the particles in any one layer which reach a higher layer, the great proportion are those which move rapidly in the lower layer. Thus there will be fewer particles in the upper layer, but the mean kinetic energy of a particle will be the same in both.

Applying these considerations to Lord Kelvin's example, it appears that the C particle, when going rapidly, will penetrate a considerable distance into the region of the repulsive force, while, when going slowly, it will only penetrate a short distance. Thus the *duration* of a slow flight might be much shorter than that of a quick one (with a force varying directly as the distance, the durations would be equal). It is quite different with the A particle, which moves uniformly to the end of the tube and back again. The duration of a slow flight will be long and of a quick flight short, being always inversely proportional to the velocity. Again, it appears evident that the chances for C having a great or small initial velocity at B are exactly the same as those for A. Hence, if we compare the velocities of A and C at an instant arbitrarily chosen, the probability of our happening on a time when A is moving slowly may be less than that of our happening on a time when C is moving slowly, and we cannot conclude that the mean kinetic energy of A is greater than that of C; indeed, a comparison of this case with that of the atmosphere, would lead us to expect that the mean kinetic energies of A and C would be equal.

There are cases in which the Boltzmann-Maxwell distribution does not hold. For instance, the case of a large particle confined at the end of a tube, with numerous small particles bombarding it. The mean kinetic energy of the large particle will depend on the range of its motion in the tube. This example would suggest the conclusion that in such cases as gases in contact with solids and liquids, where the molecules of the latter are so confined by molecular forces as to approximate to the condition of the large particle at the end of the tube, the conditions of temperature equilibrium can hardly be determined by the Boltzmann-Maxwell law.

40 Trinity College, Dublin. EDW. P. CULVERWELL.

Poincaré's Thermodynamics.

RENTRANT à Paris après une assez longue absence, je prends seulement connaissance de la dernière lettre de M. Tait. Je ne veux pas continuer une discussion qui ne saurait se prolonger sans dégénérer en une simple logomachie. Il résulte en effet des débats que M. Tait n'attribue pas le même sens que moi à certaines expressions, et en particulier au mot force électromotrice. Il me semble seulement, puisque c'était mon livre qu'il critiquait, que c'était à lui d'adopter mon langage, qui est d'ailleurs celui de tout le monde. Je m'arrêterai donc là, quoiqu'il arrive.

Je suis pourtant obligé d'insister sur un point, parce que je ne veux pas laisser suspecter ma bonne foi. M. Tait a écrit: "Nothing is said, in this connection, about Joule's experiments." En ne tenant pas compte de ces mots "in this connection," j'aurais dénaturé sa pensée. Ces mots ne m'avaient pas échappé. Ils signifient, si je ne me trompe: "dans ses rapports avec la détermination de la température absolue." Et c'est pourquoi, après avoir rappelé que j'avais décrit ces expériences à la page 164, j'ai ajouté que j'avais expliqué à la page 169 comment elles permettent de déterminer la température absolue.

POINCARÉ.

[I need scarcely say that I never dreamt of doubting the good faith of M. Poincaré. What I did (and still do) doubt is my having made my meaning clear to him. For I cannot see how such a discussion could degenerate into a mere war of words. So far as I understand myself, I have been dealing mainly with the validity of certain modes of establishing physical laws, *not* with the mere terms employed in describing the experimental facts on which they are founded.—P. G. T.]

Land and Freshwater Shells Peculiar to the British Isles.

THERE cannot be any reasonable doubt that the inland Mollusca of Britain present some peculiar features, but it is surprising, considering the amount of attention that has been devoted to them, how little exact knowledge we have of this subject. This want of knowledge is doubtless due to two principal causes—first, that so many conchologists consider varieties, and especially slight varieties, to be of little or no importance; and secondly, because those who study our native shells are, as a rule, but ill acquainted with foreign species and varieties. The publication of a list of supposed peculiar forms in the new edition of Dr. Wallace's "Island Life," will, it is hoped, direct attention to this matter. Although this list is more or less provisional, and will doubtless require much alteration as time goes on, I anticipate that the number of forms actually peculiar to our islands, when fully ascertained, will considerably exceed eighty-three, the number at present listed. On the other hand, no doubt, several at present in the list will have to be eventually struck out.

With regard to the peculiar species: *Limnæa involuta* is doubtless an isolated derivative of the *peregra*-type, to which the curious and distinct var. *burnetti* of Scotland may be said to lead. *Assiminea grayana* and *Hydrobia jenkinsi* belong to the brackish-water and salt-marsh fauna, which, as has been well observed, formerly extended far beyond its present limits. To this now-restricted fauna belong many of our peculiar Lepidoptera (see the list in "Island Life," pp. 347-350), and the probability is that most of these are destined shortly to become extinct, as the large copper butterfly (*Chrysophanus dispar*) already is. The fourth species, *Geomalacus maculosus*, is not strictly peculiar, being also found in Portugal; but it is a survival of the Lusitanian fauna, to be classed with numerous plants of similar range, recorded in "Island Life," p. 364. Thus, of the four species given as peculiar, one only is strictly endemic, having regard to its whole history; and the three others are apparently best regarded as survivals of faunæ which were formerly more widely spread.

Turning now to the varieties, we meet with a much larger proportion of truly endemic forms, though from our want of knowledge there is much uncertainty. *Limax marginatus* var. *maculatus* is quite common in parts of Ireland, and as it is a very striking form, it could not easily have been overlooked had it occurred on the Continent. The same applies with perhaps greater force to the beautiful var. *albolateralis* of *Arion ater*, which abounds in parts of Wales. The black variety of *Agriolimax agrestis* is frequent in some places in Yorkshire, and has never been detected on the Continent. But Simroth found it recently on mountains in the Azores, above the zone of cultivation; and in Sicily and Crete there is a melanic form (*panormitanus*), still more differentiated. The var. *griseus* of *A. agrestis*, found in England, and lately by Scharff in Ireland, is grey instead of black, but I am not aware that even this degree of melanism exists on the Continent, though, it is true, they have the dark brown var. *tristis*.

This melanism is well illustrated by other British slugs—namely, two forms of *Limax flavus*, and two of *Amalia sowerbyi*, and may be compared with the well-known cases of melanism so frequent among our Lepidoptera. That there is a strong tendency to the formation of melanic races in these islands cannot, I think, be doubted; and insular melanism elsewhere has been well established as a fact.

There is another class of varieties, noticed especially in the shells, characterized by a slight and yet real difference from the continental type. This sort of variation is as yet very little worked out, but most conchologists who have received common species in numbers from abroad, must have noticed how frequently they have a different *facies* from those familiar to us in Britain, though the actual difference may be so slight that we should hesitate to separate them as varieties. Quite recently, M. Bourguignat has regarded certain British specimens of *Clausilia* and *Unio* as constituting new species. Probably hardly anyone will be found to follow him in this decision, but we know how thoroughly he and his colleagues have ransacked Europe, and especially France, for novelties, so we may rest assured that in all probability these shells represent variations not existing on the Continent.

Another class consists of forms which might be set down by some as mere monstrosities, but which, nevertheless, are local in their distribution. Such are sinistral forms, which occur rarely in many species, but in many instances frequently in certain places. This form of variation is certainly inherited, and in fact has become the character of species and genera. White shells of coloured species are apt to be scoffed at as mere albinos, but the character is undoubtedly an important one, since in *Hyalinia* we have every gradation of species from those which rarely present white varieties, to those which are normally and indeed invariably white. The colourless variety of *Cochlicopa lubrica* is frequent in one or two British localities, at least, but I never heard of its occurrence on the Continent, nor in North America, where the species is abundant.

The sources of possible error, in estimating the number of peculiar forms, are obviously many, and hence the need for prolonged and careful research in the future. *Helix virgata* var. *subdeleta* is very common in England, and I formerly supposed it endemic; but recently Mr. J. T. Carrington found it at Toulon; and *Helix dautezi*, Kobelt, a supposed species from near Algesiras and Gibraltar, is almost precisely identical with it, so far as I can judge from specimens collected by the Rev. J. W. Horsley. The variety *leucozona* of the same species also seemed characteristic of the British fauna, but a form from Toulon differs but slightly from it. *Arion hortensis* var. *fallax*, with orange slime, is given as peculiar. It may, however, be the same as var. *subfuscus*, C. Pfr., which is of a brownish colour, or var. *rufescens*, which is described as reddish or orange. These would look extremely like *fallax* when the latter was covered with slime; but there is an element of uncertainty, since Dr. Scharff has shown that in *A. subfuscus*, Drap., there are two forms, one coloured reddish only by its slime, as in *fallax*, and the other with a yellow pigment in the skin. Similarly, we remain doubtful about *Helix aspersa* var. *lutescens*, a form not rare in some English localities. I know nothing described from the Continent that would agree with it, but when it loses its epidermis it agrees with the description of a French variety, and if we suppose the type of the latter to have been a weathered specimen, the two must be identical.

T. D. A. Cockerell.

Institute of Jamaica, Kingston, Jamaica, May 3.

The Former Connection of Southern Continents.

I read Mr. Lydekker's article on "The Discovery of Australian-like Mammals in South America," in Nature of May 5 (p. 11), with the greatest interest. It is worth while calling attention to a physiographic fact pointing towards a former connection between South America and Southern Africa, such as appears to be required on biological grounds, as pointed out by Mr. Lydekker.

The island of South Georgia in the Antarctic Ocean lat. 54° S., long. 37° W., is composed of clay-slate, the mountains, rising precipitately from the ocean, attaining to altitudes of from 2000 to 3000 metres (Nature, March 27, 1884, p. 509). It is about 1200 miles due east of Cape Horn, and almost exactly one-third of the way between that cape and the Cape of Good Hope.

The full significance of these facts seems hardly to have been realized, especially from a geological point of view. The existence of clay-slate rock forming mountains of an Alpine character indicates with certainty that the island is a portion of a submerged land of great extent. In "The Origin of Mountain Ranges" I have dwelt upon and developed the law that all great mountain ranges (not volcanoes) are thrown up only in areas of great sedimentation. This is true of every mountain range that has been geologically examined, and I do not know of a single exception. Keeping this law well in view, clay-slate mountains of an Alpine character protruding directly from the ocean become invested with deep meaning. They indicate vast horizontal extensions of thick sedimentary deposits which have been subjected to great lateral pressure, and have become ridged up along lines of least resistance. That such sedimentary rocks exist far and wide, forming the ocean bottom about the island of South Georgia, I have not the least doubt. A continental stepping-stone one-third of the way is a somewhat important independent support towards the land connections required by biologists between two great continents.

Park Corner, May 9. T. Mellard Reade.

The Lesser Spotted Woodpecker.

The lesser spotted woodpecker is rather a rare bird, and perhaps the following notes may be worth recording.

This house is in the fields, at the foot of the Cotswolds. Opposite my bedroom window, and only four yards distant, there is a very tall old Lombardy poplar, with a stem two feet thick. One of these birds visited this tree almost every day from the latter part of March till the 12th of this month, coming every morning between 6 and 8, and sometimes also at other hours. He fixed himself always on the same part of the stem, opposite my window, and about 25 feet from the ground; and as there are only a few small branches there, he was very plainly seen He made a remarkable sound, very loud, like the boring of a large auger, continued for one or two seconds, and repeated again and again at short intervals. While the sound continued his whole body seemed in rapid vibration, and he was tapping the tree with extreme rapidity with the point of his beak. During the intervals his head was generally moving quickly from side to side, and his beak was often turned over to plume himself. At this time the crest on his head became often a splendid object. When the sun shone on it, it was like a flash of flame, or the glitter of polished copper foil. The bird was about six inches long, with a rather thick, fluffy-looking body, the tail and back striped black and white, the stripes broadest at the tail. What he was really doing I could not determine. The stem of the tree at that place seems to be hollow, and the bark is cracked, but no hole has been bored, and no insects are seen there. I have had it examined with a long ladder. The bird has now disappeared. I think his nest has been in the stem of an ash-tree in a field not far off. There is a hole in it about the size of a tea-cup, but out of reach. I have not seen his mate, or heard any answering cry.

ALBERT C. MOTT.

Detmore, near Cheltenham, May 21.

The God of the Ethiopians.

IF we were to classify the various African tribes which speak dialects of the Bantu language-branch (the Ethiopians of Herodotus and Pomponius Mela, of Dos Santos and Merolla) according to the names by which they designate the Deity, the greater number of them would be found to fall into two great groups.

Those on the eastern coast worship a god who is known under some form of the word Unkulunkulu.

Tribe.	Name for God.	Root, meaning "great" or "old."	Derivative.
ama Mpondo	Ukulukulu	...	inkulu = great, old ubukulu = greatness ukukulwa = to make great
ama Xosa ama Zulu	Unkulunkulu	Kulu	
be Chuana	(Mokholokholo)[1]	Kholo	ekholo = great
Inhambane tribe	Mulungulu		
Tribe at L. Moero	Mulungu		
,, ,, L. Tanganika	Mulungu		
wa Yao	Mulungu	...	ukulungwa = greatness.
a Nyika	Mulungu	Kulu	
wa Kamba	Mulungu		
ma Konde	Mlungu		
ma Koa, Moçambique	Moloko (Muluku)		
,, Quillimane	Mulugo		
,, Rovumah	Mlugu		
Sofala tribes	Murungu	guru	
,, ,, of Dos Santos	Molungo		
Sena tribes	Murungu	Kuru	ikuru = great
Tete tribes	Muungu	Kuru	
L. Bangweolo tribe	Mungu		
wa Swahili, Zanzibar	Muungu	Ku	Kukuu = old Kwanza = old Kuu = morally Kubwa = physically } great ukuu ukubwa } greatness
,, C. Delgado	Mlungu		
wa Pokomo	Mungo	Ku	
ba Yanzi (Central Africa)	Molongo		
ova Hererò (South-West Africa)	Mukuru	Kuru	ou kuru = antiquity ova kuru = ancestors ova kurupa = old age

[1] This term means simply a very old person, and is not applied to God.

It will be seen that the least corrupted form of the word Unkulunkulu, or Ukulukulu, is found in the Zulu, Xosa, and Pondo dialects of the Kaffir language.

The word itself is formed from the Zulu or Xosa adjective nkulu (root kulu) "great," "grown," hence "adult," "old." Unkulunkulu therefore means primarily "the great (or old) one of the great (or old) one."

The cult paid to Unkulunkulu is a typical instance of that form of monotheism which takes its origin from ancestor worship. The Kaffirs call him their progenitor. Unkulunkulu ukobu wetu.

The above table appears to show that, in Molungo, Mulungulu, Mlugu, or Mungu, the term thus variously modified is derived directly from the full form Unkulunkulu (perhaps originally Munkulunkulu), and thereafter corrupted by phonetic decay, instead of being in each case derived independently, like the archaic form, from the adjective signifying "great" in the language to which it belongs.

The inference, therefore, seems to be that the word Munkulunkulu was used (not necessarily in its present sense) by the common ancestors of all the Eastern Bantu tribes from the River Dana to the Great Fish River, whose descendants still retain the name in their vocabularies, and still hold it in veneration.

On the western coast this name seems replaced by a word which may be most conveniently referred to under its most common form Nzambi.

Tribe.	Name of God.
di Wala i Subu	Nyambi
n Halemoe	Nyama
be Nga ba Seke	Nyambi
o Rungu	Anyambi
m Pongwe	Njambi
m Bete	Ndshambi
a Shira	Aniembie, Njambe
ba Kele	Nshambi
ba Nyombe	Ndzambi
Loango tribes	Zambi
Kabinda tribes	Nzambi Pongo
Ka Kongo tribes Angoy tribes	Zumbi
ba Sundi	Ndzambi à pungo
ba Teke	Ndshambe, Nshami, &c.
ba Yansi	Nzambi, Nyambi
ba Buma	Ndshambi
eshi Kongo	Nzambi, Nzambi ampungo
ba Lunda	Zambi
ba Bunda	Onzambi
ma Ngala	Nsambi
ba Bihe	Nzambi
ba Rotse	Nyampe
ova Herero	Ndyambi

The worship of Nzambi is inextricably commingled with that of fetishes and idols, and has doubtless been still further corrupted by contact with the Portuguese missionaries who were so active in the work of conversion in the Congo Empire in the seventeenth century. But there is reason to believe that in its primitive conception Nzambi was a celestial being or force, a Nature spirit like Zeus or Indra, who ruled the sky or controlled the tempest.

Among the Isubu, *e.g.*, a cognate form signifies "heaven," and such is the case also at Cape Lopez. Winwood Read's Mpongwe raised their hands to heaven when they appealed to Njambi to save them from the hurricane; and his Ashira slave pointed in the same direction when questioned on the subject of the deity. The Manyombe regard Nyambi as heaven, and the Basundi call him the "spirit on high"; and according to Kólbe the otyi Herero term Karunga Ondyambi = "heavenly bestower," "who gives and withholds rain."

The word bears little evidence of change, and is perhaps of comparatively modern origin.

It appears, therefore, that while the Eastern Bantus, who worship Unkulunkulu, indulge in *ahnen-cult*, the western adherents of Nzambi are more or less Nature worshippers. In this respect they appear to approach the Negroes of the Gold, Slave, and Oil Coasts.

A third and smaller, but very distinct group apply the term Morimo or Molimo to their conception of the deity. I refer to the Barolong, the Basuto, the Batlapin, and other clans, which are generally classed together as the Bechuana tribes. "Morimo" is the singular form of a word the plural of which, barimo, balimo, bedimo, bazimo, is found almost universally among the Bantu tribes to denote the spirits of the dead.

The application of the singular form, Morimo, Molimo, in a specialized and restricted sense to the Supreme Being is confined almost entirely to the Bechuana tribes, and has perhaps been only recently used in this monotheistic sense; although John Pory mentions (in his edition of Leo Africanus, A.D. 1600) Muzimo as the one god of the Monomotápa tribes, and Gravenbroek (A.D. 1695) says of the Kaffirs of Zimboe, "Divinitatem aliquem Messimo dictam in lucis summo cultu venerantur."

One other tribe, the Lomwe, who live east of Lake Kilwa among the Namuli Hills, use the word Murimu for God; in this respect differing from their Makoa foes, who worship Mlugu; but this rather leads one to conclude that this tribe is an outlying Bechuana clan. Mr. O'Neill has pointed out the peculiarities of language and architecture which distinguish the Lomwe from their neighbours. W. HAMMOND TOOKE.

Cape Town.

Aurora Borealis.

HAVE any of your readers observed the display of aurora borealis to-night (Wednesday)? I regret that insufficient knowledge of astronomical technicalities does not permit me to describe more exactly the size and position of the display. It appeared between 11 and 11.30 p.m., as white streaks or bands of light, varying in width and intensity, now shooting up a considerable distance, now dying away. It was especially brilliant just to the right of the constellation of Cassiopeia, and this was its furthest eastward limit; it extended more or less across the whole northern sky, and at times was bright enough to dim the stars it covered. The rays appeared to shoot up high into the sky above Cassiopeia. It was a very beautiful phenomenon, and was possibly more distinct in more northern latitudes. WARINGTON STOCK.

S. Paul's Vicarage, Derby, May 18.

THE NEW ELEMENT, MASRIUM.

FURTHER details concerning the new element, whose probable existence was announced in a paper communicated to the Chemical Society at their meeting on April 21, are contributed to the number of the *Chemiker Zeitung* dated May 11. The mineral containing the new substance was discovered in 1890 by Johnson Pacha in the bed of an old river in Upper Egypt long since dried up, but of the former existence of which there are records dating back some 6000 years. Indeed, the name by which it is known in the neighbourhood is "Bahr-bela-Mā," or "river without water." Here and there in the track of the old watercourse are small lakes whose water is of considerable repute for its medicinal value. Specimens of the mineral were sent by Johnson Pacha to the Khedivial Laboratory at Cairo, where it was examined by Messrs. H. Droop Richmond and Hussein Off, the authors of the paper laid before the Chemical Society. The mineral is found to be a fibrous variety of a mixed aluminium and iron alum containing ferrous, manganous, and cobaltous oxides. In addition, however, to these ordinary constituents, a small quantity of the oxide of another element would appear to be present, having properties entirely different from those of any yet known. This element the discoverers have termed *masrium*, from the Arabic name for Egypt, and the mineral has accordingly received the name of *masrite*. The symbol adopted for masrium is Ms.

The composition of masrite may be expressed by the formula $(Al,Fe)_2O_3 . (Ms, Mn, Co, Fe)O . 4SO_3 . 20H_2O$. The amount of masrium present is very small, averaging only about 0·2 per cent., but by working upon fifteen kilograms of the mineral a considerable quantity of the element in the form of various salts has been accumulated. A typical analysis of masrite published in the Proceedings of the Chemical Society is as follows:—

Water	40·35
Insoluble matter	2·61
Alumina	10·62
Ferric oxide	1·63
Masrium oxide	0·20
Manganous oxide	2·56
Cobaltous oxide	1·02
Ferrous oxide	4·23
Sulphuric oxide	36·78
	100·00

Suspicions that the mineral contained some hitherto unknown constituent were first aroused by the fact that when it was dissolved in water, and sulphuretted hydrogen was passed slowly through the solution in presence of acetic acid, instead of the expected black precipitate of sulphide of cobalt a white insoluble substance was first precipitated. This white precipitate continued to form until the new substance in the solution was all used up, when black sulphide of cobalt began to be thrown down. By decantation before the formation of the latter, and subsequent washing with dilute hydrochloric acid, the white substance was isolated in a state of tolerable purity. It was found to dissolve in boiling nitrohydrochloric acid. The solution in *aqua regia* was evaporated in order to remove the excess of acid, and ammonium hydrate added, when a voluminous white precipitate of the hydrate of the new metal was thrown down. The hydrate was washed by decantation, and subsequently dissolved in the minimum excess of sulphuric acid. The solution of the sulphate of the new metal was next evaporated to syrupy consistency, water was added until complete solution was just effected, and the solution mixed with an equal bulk of alcohol. The effect of this addition of alcohol was to cause immediate precipitation of crystals of the sulphate of the new metal, a further crop of which was also obtained upon evaporation. By repeated recrystallization most of the small quantity of iron present was removed. In order to eliminate the last traces of admixed ferrous sulphate, the crystals were redissolved in water, and excess of sodium hydrate added. As the hydrate of the new metal is soluble in excess of soda, the hydrated oxide of iron was readily removed by filtration. Upon the addition of ammonium chloride the white hydrate was precipitated in a gelatinous form; the hydrate was redissolved in hydrochloric acid, and again precipitated and washed. The almost perfectly pure hydrate so obtained was then finally converted to chloride by solution in hydrochloric acid.

In order to obtain data as to the atomic weight of masrium the following determinations were made. A known quantity of the chloride solution was precipitated by ammonia, and the hydrate thus obtained was ignited, and the remaining oxide weighed. A second portion was precipitated by a solution of microcosmic salt in presence of ammonia, and the phosphate obtained ignited and weighed. The chlorine contained in a third portion was determined by means of silver nitrate in the ordinary manner. From the numbers so obtained the equivalent of masrium was calculated. A pure preparation of masrium oxalate was also obtained by precipitating the neutral solution of the chloride with ammonium oxalate, masrium oxalate resembling the oxalate of calcium in being insoluble under such conditions. The precipitated oxalate was washed, dried, and ignited in a combustion tube whose forward end was filled with copper oxide, when the salt was decomposed with elimination of its water of crystallization, which was absorbed and weighed in the usual manner. The residual oxide was also weighed, and the oxalic acid, in another quantity of the salt, was determined by means of a standard solution of potassium permanganate. The crystals of the oxalate were thus found to contain 52·70 per cent. of masrium oxide, 15·85 per cent. of oxalic anhydride, and 31·27 per cent. of water.

From the whole of the analytical data yet obtained, assuming, as the reactions of the salts would indicate, that masrium is a divalent element, the atomic weight would appear to be 228. An element of atomic weight about 225 is, indeed, required to occupy a vacant place in the periodic system in the beryllium-calcium group, and masrium appears likely to be the element in question.

Masrium has only yet been observed to combine with oxygen in one proportion, to form the oxide MsO. Masrium oxide is a white substance much resembling the oxides of the lime group. The chloride, $MsCl_2$, is obtained upon evaporation of a solution of the oxide or hydrate in hydrochloric acid. The nitrate, $Ms(NO_3)_2$, crystallizes from 50 per cent. alcohol, and the crystals contain water, the amount of which has not been determined. The sulphate, $MsSO_4 \cdot 8H_2O$, is a white salt which crystallizes badly from water, but which separates in well-developed crystals from 50 per cent. alcohol. It combines with sulphate of alumina to form an alum, also with potassium sulphate to form a double sulphate. The oxalate above referred to, $MsC_2O_4 \, . \, 8H_2O$, is a white salt, soluble in acetic acid, and also in excess of masrium chloride.

The most important reactions of the salts of masrium, as far as they have yet been studied, are the following. Sulphuretted hydrogen produces no precipitate in presence of hydrochloric acid, but yields a white precipitate in presence of acetic acid. Ammonia precipitates the white hydrate of masrium from solutions of the salts; the hydrate is insoluble in excess of ammonia. Ammonium sulphide and carbonate produce white gelatinous precipitates, likewise insoluble in excess of the reagents. Ammonium phosphate yields a white precipitate of phosphate. Caustic alkalies precipitate the hydrate, but the precipitate is readily soluble in excess of the alkaline hydrate. Potassium ferrocyanide produces a white precipitate which is soluble in excess of masrium chloride, but not in dilute hydrochloric acid. Potassium ferricyanide yields no precipitate. Potassium chromate precipitates yellow chromate of masrium, which is soluble in a further quantity of masrium chloride. Potassium tartrate yields a white tartrate precipitate which dissolves in excess of the reagent, but the solution is not reprecipitated by the addition of ammonia.

Metallic masrium has not yet been obtained. Attempts to isolate it by heating the chloride with sodium under a layer of common salt, and by the electrolysis of a solution of the cyanide proved unsuccessful. The chloride, moreover, is not sufficiently volatile to permit of its vapour density being determined.

From the above interesting reactions, however, it will be evident that masrium possesses a strong individuality, although on the whole behaving somewhat like the metals of the alkaline earths and those of the zinc group. Further work will doubtless afford more definite information concerning its nature and properties. A. E. Tutton.

ON A NEW METHOD OF VIEWING NEWTON'S RINGS.

If we observe the reflection of a rectangular strip of any opaque substance (A) about ¼ inch wide in a piece of plate glass *of about the same thickness*, it appears thus:—

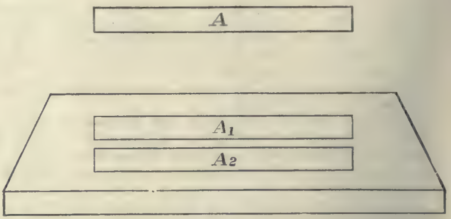

Fig. 1.

A_1 A_2 being the reflections caused by the upper and lower surfaces of the glass respectively.

If a second glass plate, of the same thickness, be added beneath the first, there is a third reflection (A_4) added below A_2 thus, drawing only the reflections for simplicity's sake:—

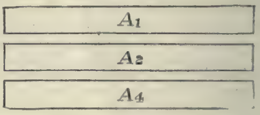

Fig. 2.

Now if the upper slab of glass be *gradually* raised above the lower, the opaque strip remaining in position, the reflection A_2 (Fig. 2), which generally exhibits traces of colour when plate glass is used, splits up into two (A_2 A_3), thus:—

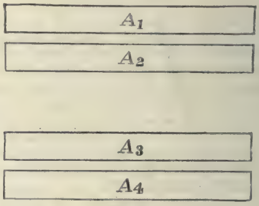

Fig. 3.

Thus it is proved that A_2 (Fig. 2) is the resultant of the reflections of the strip by the lower surface of the upper plate, and the upper surface of the lower plate (A_2 and A_3, Fig. 3, respectively).

In saying that A_1 is the reflection of A caused by the top surface, we mean that light which would fall on that surface and be reflected to the eye is prevented from so doing by the presence of A; and so with respect to the other reflections: thus, if any one of the reflections is not perfectly dark, we can assert that the light seen in it is at any rate not due to reflection (for the first time) at the corresponding surface; *e.g.* A_4 (Fig. 2) appears anything but dark, and we may assert that the light seen in it is not reflected from the bottom surface of the lower plate (at all events for the first time).

Now by means of two similar rectangular strips A and B, placed with their long sides parallel to the surface of the glass, B being further from the observer and from the top plate, it is very easy to arrange them so that B_4—the reflection of B in the lower surface of the lower plate—

apparently coincides with A_1—the reflection of A in the upper surface of the upper plate; and thus, neglecting for the time light which has undergone more than one reflection, we see this A_1B_4 combination of reflections illuminated by light which has undergone reflection at the two inner surfaces only.

It is clear that if we substitute for the two glass plates the apparatus generally sold for exhibiting Newton's rings, we can by this simple method view the rings by the light proceeding from the two inner surfaces only. Thus viewed, the central dark spot appears of a rich velvety black, and the coloured rings very brilliant. The experiment can easily be projected, and the difference in the appearance of the rings on the screen, with and without the opaque screens, is very striking.

The effect of the two screens can be still more simply given by cutting a slit in a piece of blackened cardboard of about the same width as the thickness of one of the glass plates in the rings apparatus; it is almost needless to state that the cardboard in the region of the upper and lower edges of the slit performs the functions of the screens B and A respectively. In this way the backing of the lower glass plate (to get rid of the reflection from its lower surface) may be avoided; an obvious advantage when it is desirable to show the interference in the transmitted as well as in the reflected light.

But the interest of the method does not only lie in its simplicity. Besides affording an easy proof that the rings are caused by light reflected at the inner surfaces of the plates, it also gives a method of seeing and possibly differentiating the interference curves produced by light which has undergone only one reflection, *i.e.* the rings commonly known as Newton's, from the curves produced by the interferences of waves which have undergone two reflections or more (and these last, so far as I know, can only be shown by this method); for if, using the ring apparatus and a single opaque screen, say 3 inches × ⅓ inch, we look into the central reflection (A_2) carefully, two sets of rings, intersecting, can be seen. These cannot be due to light reflected at the points whence the rays which form the primary rings are reflected—by what has gone before.

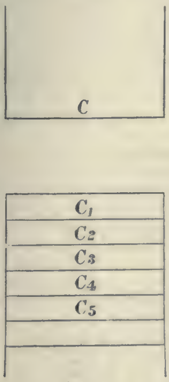

Fig. 4.

To indicate, without attempting for the present any further analysis, how some of the other interference systems may be rendered visible:—Take a strip of blackened cardboard, say 8 inches × 2½ inches, and view its reflections in the Newton's rings apparatus. C (see Fig. 4) being the lower portion of this new screen, its reflection will be seen to consist of a number of shaded strips, C_1, C_2, C_3, &c.; and in each of these will be evident different interference curves (plainer, of course, when monochromatic light is used); in C_1 the primary rings; in C_2 two series of rings crossed; in C_3 still more complicated forms, and so on; each set fainter than the last, the light to which it is due having undergone more reflections than its predecessor. The method suggested for the experimental analysis of these interference systems can only be sketched roughly here. It is, by the use of a second screen, possibly a third, so to combine the reflections of the screens with observations of the consequent alteration in the interference curves, as to completely verify the results a mathematical analysis of the problem would predict. T. C. PORTER.

JEAN SERVAIS STAS.

FEW, if any, among the men of science of the present day have at once done such important work and earned so little popular recognition as Jean Servais Stas. The names of Faraday, Liebig, Dumas, Darwin, have become household words beyond the laboratory and the lecture theatre, and are frequently taken in vain by the purveyors of "science for the million." But, whether among the "classes" or the "masses," if we mention Stas we are apt to be asked, Who was he? What has he done? If we mention his determination of the atomic weights, we have to follow this statement up with a popular lecture on stöchiometry, and are then told that there is not much in it.

Stas was born at Louvain, on August 21, 1813. Like many young men of scientific tastes in the earlier part of the century, he entered upon the study of medicine, and graduated as M.D. But, feeling himself strongly drawn to chemical research, he came to the conclusion that the life of a practising physician was not his true sphere. So early as 1835 he undertook, in conjunction with his friend De Koninck, an investigation of the root-bark of the apple-tree, and discovered phloridzine, an interesting crystalline body. However, at the outset he merely succeeded in obtaining this body in its pure state and in ascertaining its behaviour with reagents. He decided to go further, and to study the constitution and transformations of phloridzine. To this end he stood in need of further instruction. But the methods of organic investigation were at that time little advanced. The art of research was taught only by Liebig at Giessen, and by Dumas at Paris. Stas made choice of Dumas, and after overcoming endless difficulties, was admitted as a pupil in the laboratory of that distinguished Academician.

Here, he resumed the study of phloridzine, and soon succeeded in determining its formula, and those of its principal derivatives. He ascertained that in contact with acids, phloridzine was split into glucose and phloretin, thus belonging to the class of glucosides, bodies the prototype of which had been discovered by Liebig and Wöhler in amygdaline. Berzelius, a man by no means lavish of praise, declared that "from an investigator who has carried out such a research much may be expected."

Impressed with the ability of his pupil, Dumas requested him to undertake a series of investigations in concert with himself. The first of these researches was the examination of the action of potassa-lime on alcohols. They determined that, without exception, alcohols were transformed into corresponding acids. By their powers methylic alcohol yielded formic acid, and ethylic alcohol yielded acetic acid. Fusel-oil gave a valerianic acid exactly agreeing in its properties with the natural valerianic acid—a discovery of great importance considering the paucity of synthetic organic compounds then known. In conjunction with his master, he ascertained the molecular weight of valerianic acid by a determination of its vapour density and by its conversion into tri- and tetra-chlorvalerianic acid, thus justifying their joint belief as to the alcoholic nature of fusel-oil. This conclusion was experimentally confirmed by the conversion of fusel-oil into valeraldehyde.

Immediately after these experiments, Stas, aided by Dumas, entered on the most important work of his life. It had been already found that on the combustion of the more highly carbonized hydrocarbons the sum of the carbon and hydrogen was decidedly greater than the weight of the substance taken for analysis. Two possible explanations were suggested. The excess might be due to a constant error in the method employed, but on careful and frequent repetition of the experiments no such error could be traced; or there remained the possibility that the composition either of carbon dioxide or that of water had not hitherto been accurately determined. In deciding this question Dumas and Stas developed precautions which had never been equalled, and which certainly have not been since surpassed.

It must be remembered that, like Darwin in another department of science, Stas was his own most acute and formidable critic. He seems never to have wearied in devising possible objections to his methods and results, nor of suggesting loop-holes through which errors might possibly have crept. In redetermining the atomic weight of carbon, graphite (natural and artificial) and diamonds were submitted to combustion in a current of perfectly dry oxygen. After the checking and re-checking of results, the operators were forced to conclude that the true atomic weight of carbon was lower than hitherto had been universally accepted. It had been determined by Berzelius and Dulong as 12·24. Dumas and Stas made it simply 12, and confirmed the result by carefully repeated analyses of many substances of known composition. Hence Dumas was led to accept for the atomic weight of oxygen 16, and for that of nitrogen 14. Whilst Dumas and Boussingault executed their determinations in Paris, Stas carried out the same experiments by the same method at Brussels.

These startling results recalled the attention of chemists to the hypothesis of Prout, *i.e.* that the atomic weights of all the elements must be multiples of that of hydrogen ($H = 1$), by a series of whole numbers. Into this question Dumas and Stas threw themselves heart and soul. The experimenters came to separate conclusions. Stas entered the investigation in the full conviction that he should find the principle of Prout exactly confirmed. At the conclusion of his arduous labours, he found his expectations to be "pure illusion."

On the other hand, Dumas sought to retain the hypothesis in a modified form.

Neither of these eminent researchers seems to have paid sufficient attention to the fact that the atomic weights of a considerable number of the elements differ but very slightly, in excess or in deficiency, from the values which the hypothesis of Prout would require. It is quite possible we are here in presence of a residual phenomenon which interferes with the exactitude of the law.

In a paper recently read by Prof. W. Spring before the Belgian Academy of Sciences the speaker gave an abstract of the unpublished researches of Stas. In a certain memoir, "On Silver," was discussed a treatise by Dumas on the quantity of gases absorbed by silver, in which Dumas had conceived doubts as to the conclusions of Stas on the hypothesis of Prout. For the critical purpose Stas prepared absolutely pure silver, containing not a trace of gases nor of kindred metals. At the melting-point of iridium the silver was volatilized without revealing by the spectroscope any trace of sodium, a metal which Dumas had suggested as being possibly present. This pure silver gave the same atomic weight as the silver used previously by Stas. Hence the atomic weight of silver must retain the value which Stas, in his earliest determinations, had assigned to it, and consequently the objections of Dumas fall to the ground.

A second Stas memoir, recently brought to light, fully investigates the question whether the elements sodium, potassium, lithium, calcium, strontium, barium, and thallium can be mutually transformed either by intense heat or by electric action. To carry out his experiments, undertaken in consequence of the views lately expressed, that the spectra of the above metals assume a different aspect at very high temperatures, Stas required materials chemically, or rather spectroscopically, pure. This difficult task took him eleven years to accomplish. As a result he found that even at the melting-point of iridium (from 2200° to 2500°) the spectral lines of the metals remained unaltered, and that consequently the transmutation of elements under the special circumstance is devoid of foundation. The error may have arisen, as Stas suggests, from the use of materials not absolutely pure.

In this course of experiments he verified the distinction pointed out by Bunsen between the flame spectra and the electric spark spectra of metals. The flame spectrum of sodium, even at the most intense temperature, shows the well-known double yellow line. But in the complete electric spark spectrum there appear six double lines, lying respectively in the orange red, the yellow, the greenish-yellow, the green, the greenish blue, and the violet. In the solar spectrum all these six double lines are represented by black lines. In the spectrum of the electric arc may be recognized the six double lines, but in the intense white light of the poles merely the flame spectrum with its double yellow line.

The results of his investigation Stas describes in a discourse entitled "De la Nature de la Lumière Solaire," delivered in 1891. From the coincidence of the lines of the metals as recognized in the spark-spectrum with Frauenhofer's dark lines in the solar spectrum, Stas inferred that the heat and light of the chromosphere were produced by disruptive discharges.

The daily life of Stas was by no means devoid of troubles. Posts of honour, indeed, were showered upon him both in his own country and abroad. He was Vice-President of the Belgian Sanitary Council, technical assessor of the National Bank, a perpetual member of the Council of Administrators of the University of Brussels, a member of the Statistical Bureau, President of the Belgian Academy of Sciences, Honorary Fellow of the Royal Society (which conferred on him the Davy Medal), Corresponding Member of the French Academy of Sciences, and of the majority of the more distinguished Academies and scientific Societies. So far back as 1873, he was elected an honorary member of the German Chemical Society. He was also a Grand Officer of the Belgian Order of Leopold and of the French Legion of Honour, as well as a knight of many orders throughout Europe.

His earliest remunerative position was that of Professor of Chemistry at the Military School of Brussels, a post he successfully filled for more than a quarter of a century. So paltry was the salary attached to this office that he finally petitioned Government for an increase. His request was granted, but in a fashion worse than refusal. He was voted an additional salary of 200 francs—a sum he naturally disdained to accept. Soon after he suffered from an affection of the larynx, which put an end to the delivery of lectures. He was compelled to tender his resignation, but as he had not completed the thirty years of service extorted by law he missed his pension. From this plight he was rescued by the offer of a post in connection with the Mint (Commissaire des Monnaies). The respite from trouble was brief. A syndicate of speculative capitalists proposed to the Government to coin an enormous sum of francs. With the full concurrence of the Minister of Finance, Stas resolutely resisted a scheme he considered dangerous to the interests of the nation. With a change of Ministry the proposed measure was carried. Stas forthwith resigned his post in the Mint, preferring to sacrifice emolument rather than countenance a step which he knew to be detrimental.

Stas not unfrequently engaged in tasks which appeal more directly to the popular mind than the determination of atomic weights. In 1850, Belgium was thrown into excitement by a poisoning case not less sensational than that of Palmer in our own country. It has been said of Belgium that it is less permissible to knock down an *ouvrier* than to murder a nobleman. A Count Bocarme had poisoned his brother-in-law. Had the crime in question been committed by one of the *people*, it might, if not condoned, have been inquired into in a somewhat perfunctory manner. But as the only man to whom suspicion pointed was an aristocrat, a searching investigation was demanded by an indignant public. The chemical investigation conducted by Stas was performed in a masterly manner. The unerring chemist not only detected nicotine poison, but also the exact quantity which had been administered. The guilt of Count Bocarme was much more satisfactorily established than that of Palmer in the Rugeley case.

With characteristic thoroughness Stas was not satisfied with the mere detection and quantitative determination of nicotine. He elaborated a general method for the recognition of organic poisons in chemico-legal investigations. His method of detection, revised and perfected by Julius Otto, is still in general use among toxicologists, under the name of the Stas-Otto process.

At the London International Exhibition of 1862, to Stas was intrusted the report on the industry of oils and fats. The question was discussed whether the old method of saponification by means of alkalies or the recently invented acid saponification was to be preferred. The experiments of Stas demonstrated not only the superiority of the acid process from an economical point of view, but supplied the industrial world with the working details of a method still followed by the manufacturers of stearine candles.

At the initial meeting of the International Committee of Weights and Measures held at Paris in 1875, Stas appeared as the Belgian representative, and took a very active part in its labours. From 1877 to 1879 he was associated partly with H. Ste. Claire Deville, and partly with C. J. Broch in the selection of the metals to be used as standards or prototypes for weights and measures. The alloy selected consisted of 90 per cent. of platinum, and 10 per cent. of iridium. The reports are rich in important observations on the properties of the platinum metals. Unfortunately they have been published, so far as the writer is aware, only in the *Procès-Verbaux du Comité International des Poids et Mesures*, documents not readily accessible. The results have still to find their way into the text-books and metallurgical manuals.

But other labours of the illustrious Belgian chemist have still to be unearthed. At the request of his Government he carried out important researches on metallic alloys for the manufacture of heavy artillery. His copious reports are said to be buried in the archives of the Belgian War Department.

In one quarter only did Stas encounter ill will. He was a champion of the freedom of research and of the independence of the Universities. Hence he came into frequent collision with the "clerical party," which in Belgium plays a *rôle* similar to that of the ethicists and self-constituted "anti-" Societies in Britain.

On January 1, 1891, at the King's New Year reception he courageously reminded the Ministry of the respect which a Government owes to science. We regret we have not met with the text of this discourse, which would be worth reproduction in England. The insulting replies to the bold utterance of Stas were drowned in the loud and general approval of the country.

It is pleasant to add that the personal character of Stas was in harmony with his scientific pre-eminence. He was a man of whom it could be said, "Nihil tetigit quod non ornavit." It was one of his great distinctions that, unlike many illustrious men of science, he was not followed to the grave by the ghosts of dead theories.

NOTES.

Men of science were glad to see that the list of those on whom birthday honours were conferred included Dr. John Evans, who has become a K.C.B.; Mr. W. T. Thiselton Dyer, who has been made a C.I.E.; and Mr. H. H. Howorth, who has been made a K.C.I.E.

The annual visitation of the Royal Observatory at Greenwich will take place on Saturday, June 4.

The Secretary of the British Association Committee for arranging for the occupation of a table at the laboratory of the Marine Biological Association, at Plymouth, requests us to announce that applications for the use of the table during the present summer should be addressed to him (Mr. S. F. Harmer, King's College, Cambridge) not later than Friday, June 10.

Mr. Walter Garstang, M.A., Berkeley Fellow of the Owens College, Manchester, and formerly assistant to the Director of the Marine Biological Association, has been appointed to a naturalist's post upon the staff of the Marine Biological Association at Plymouth, and will have charge of the dredging and collecting operations conducted at the station.

In the fifth Annual Report of the Liverpool Marine Biology Committee (December 1891), Prof. Herdman suggested that the marine biological station might with advantage be changed from Puffin Island to some more easily accessible part of the district, where a fresh area could be investigated. After a careful consideration of several sites, the Committee decided upon Port Erin, at the south end of the Isle of Man, and a suitable building for a marine laboratory, of three rooms, has now been erected, on the beach immediately below the Bellevue Hotel, from plans prepared by Prof. Herdman. This laboratory being ready for workers, and a number of members of the Liverpool Biological and other scientific societies, and also of the Isle of Man Natural History and Antiquarian Society, having expressed an interest in the progress of the undertaking, the Committee have resolved to inaugurate the station by a formal opening on Saturday, June 4. The Lieutenant-Governor of the Island, Mr. Spencer Walpole, has consented to perform the ceremony; and His Excellency, and the Bishop of Sodor and Man, have accepted the invitation of the Committee to be present at a luncheon to be given at the Bellevue Hotel on the occasion.

The Puffin Island Biological Station has been taken over by several members of the staff of the University College of North Wales, Bangor, and will be worked henceforth in connection with that College. Dr. Philip White, the lecturer on zoology, has been appointed director of the station. The island is in full view of, and within easy reach of, the College. The station, as formerly, will be entirely supported by voluntary contributions.

The Marine Biological Laboratory at Wood's Holl, Massachusetts, will be open for investigators from June 1 to August 30. The demand for tables at the laboratory has been so great that the trustees decided some time ago to enlarge the building, and a spacious new wing will be ready for use on July 1. Various courses of instruction in zoology, botany, and microscopical technique will be given, as usual, during the season. Lectures on special subjects will also be delivered by members of the staff.

THE annual *conversazione* of the Society of Arts will take place at the South Kensington Museum on Wednesday evening, June 29.

THE German Anthropological Society will hold its general meeting this year at Ulm, beginning work on July 31. Arrangements have been made for some very pleasant excursions in the neighbourhood.

MAJOR-GENERAL NOBLE, R.A., died on Tuesday, May 17, in his fifty-eighth year. He was well known, not only as the author of books on military subjects, but as the inventor of various scientific instruments connected with the manufacture of guns and gunpowder.

THE University of Heidelberg has conferred the degree of Doctor of Natural Philosophy, *honoris causâ*, on the well-known entomologist, Baron Osten Sacken.

THE beautiful illustrations contained in the *Black and White* Hand-book to the Royal Academy and New Gallery pictures are sure to be welcomed by those who have not already seen them, while to those who have visited these Galleries good reproductions of them will not be amiss. The different coloured tints given to the pictures produce a pleasant variety of impression, while the fidelity to the original details, which is the chief feature of photographic processes, is here thoroughly maintained. Not only the pictures, but the specimens of sculpture, are reproduced in the same way, the results being equally successful. As an introduction to the volume, a brief but interesting account is given of the Royal Academy, together with illustrated biographies of the present Academicians and Associates.

PART I. of Mr. G. J. Romanes's treatise, "Darwin and after Darwin," was published a day or two ago by Messrs. Longmans, Green, and Co. It deals in a critical manner with the distinctively Darwinian theory, or the evidences of evolution as a fact, and of natural selection (with sexual selection) as a method. It is copiously illustrated, for the most part with original woodcuts, and runs to 450 pages. We gather from the preface that Part II. is to treat in a similar spirit of "Post-Darwinian Theories" (heredity, utility, isolation, physiological selection, &c.); and understand that it will probably be ready for publication in the autumn season.

ON April 29, Mauritius was visited by the most terrible hurricane that is known to have ever devastated the island. According to the official telegram from the Acting Governor to the Secretary of State for the Colonies, one-third of Port Louis was destroyed. The Royal College, twenty-four churches and chapels, and many sugar-mills in the country were completely wrecked. There were over 600 deaths in Port Louis; over 300 deaths in the country and over 1000 wounded. "In Port Louis district," the telegram continued, "returns incomplete; probably same amount. No loss among the military. Estimated reduction of crop one-half. Destruction to property enormous. No famine apprehended. All relief measures taken. Relief committee appointed. Panic allayed. Order and quiet reign, but, in presence of thousands of homeless people, pecuniary assistance urgently needed." A public subscription in aid of the sufferers was at once opened by the Lord Mayor. It is to be hoped that the Observatory at Mauritius has been spared. It was thence that Dr. Meldrum announced that at Mauritius the hurricanes and wrecks varied with the sun-spots. We have again a maximum of sun-spots and unprecedented devastation.

THE National Home Reading Society will hold two summer assemblies this year, one at Weston-super-Mare, the other at Bowness. The former will last from June 25 to July 2, the latter from June 27 to July 2. At both meetings science will be well represented among the subjects of study. At Weston-super-Mare, Prof. Lloyd Morgan will lecture on "The Physical History of the Mendip Hills," Sir Robert Ball on "How came the Great Ice Age?", Dr. Dallinger on "Ants: a Study of Sociology and Politics among Insects," Dr. C. W. Kimmins on "Flowers and their Insect Visitors," Mr. A. W. Clayden on "Geological Structure and the Formation of Scenery." At Bowness, Mr. J. E. Marr and Mr. G. Massee will give geological and botanical lectures, but the chief work of the classes in geology and botany will be done in the course of excursions to the places of scientific interest in the Lake District. Both assemblies are likely to be of great service to all who attend them.

MR. GEORGE FORBES arrived on May 6 at the Niagara Falls in company with the executive officers of the Cataract Construction Company. He is acting as the Company's adviser in connection with the plans he submitted to them in 1890 for the transmission of electrical power from the Falls to Buffalo. When the Company appointed a commission of Sir William Thomson, Mascart, Colonel Turrettini, and others to examine the plans, Mr. Forbes gave them as his mature opinion the assurance that they must use alternating currents, and for motors either the ordinary alternator, as first used by Wilde, or the rotating field (Drehstrom), as then used by Tesla, which Mr. Forbes had tested at Pittsburg. These alternating currents to be used with transformers for lighting, and coupled to motors as described for general power, but for electric tramways and some other purposes the alternating motors were to drive continuous current dynamos. These plans were not approved by the commission, and a resolution was nearly passed saying that alternating currents could not be used for the purpose. There was only one dissentient voice, but in the end no resolution was passed. Turrettini and Mascart are now both converted, and Mr. Forbes's plans have been adopted.

MUCH interest has been excited in Philadelphia by a loan collection of objects used in worship, exhibited in the Museum of Archæology of the University of Pennsylvania. Most of the leading religions of the world are represented in the collection. The objects are arranged in accordance with the plan adopted at the Guimet Museum, Paris, and the managers have tried to make up for gaps by notes in the catalogue, which is a closely printed octavo of 174 pages. One result of the exhibition has been that it has brought to light many objects of scientific importance, the significance and value of which were not formerly known by the possessors.

MR. JOHN H. COOKE has made a valuable addition to the Museum of the Malta University. The *Mediterranean Naturalist* describes the gift as a suite of the Maltese fossil Echinoidea, similar to those that have lately been presented by the same gentleman to the British Museum and to the University of Bologna.

A WRITER in the May number of the *Mediterranean Naturalist*, speaking of the colours of the waters of the Mediterranean, says they vary considerably at different seasons of the year and in different localities. During storms and boisterous weather the sea assumes a deep green and sometimes a brownish tint, but when calm and undisturbed it is of a bright, deep blue. In the Bosphorus, and among the islands of the Archipelago, the water is of varying tints, in some places being of a liquid blue graduating into a brighter green, and in others assuming a blue so deep in its intensity as to almost approach a purple.

MR. K. SEKIYA AND MR. F. OMORI contribute to the new volume of the Transactions of the Seismological Society of Japan a most careful paper presenting a comparison of earthquake measurements made in a pit and on the surface ground. It is generally thought that the earthquake motion is considerably less in a pit than on the surface. The conclusion of these inquirers is that for small earthquakes there is no practical difference between the surface and underground observations. For the principal undulations of severe earthquakes a difference may exist, but not to any marked degree; but for small quick vibrations the difference is considerable. Though the calculation for the ripples may be only approximate, their maximum velocities and maximum accelerations are found to be very great, and, in fact, many times greater than those for the principal undulations. Thus, if these ripples are really in great part smoothed away in the pit, it is very likely that in the case of very severe earthquakes there might be less destructive action in deep pits than on the free surface.

THE weather during the past week has been less settled generally than for some time past, although for the most part it was fine and dry over the south and east of England. The distribution of atmospheric pressure was favourable to a westerly type of wind, the barometer being highest over the south of our islands, and lowest over Scotland. An anticyclone was situated over France and Spain throughout the period, and the southern portion of England came greatly under its influence. Several depressions reached the northern parts of the kingdom from the Atlantic, and caused strong winds and gales at some places. The rainfall was considerable in the north and west, amounting to one inch at Stornoway on Monday, but slight in other parts. Bright sunshine was less prevalent; the Meteorological Office report for the week ended the 21st shows that it was below the average in all districts except the Channel Islands. A thick fog occurred over the south of England and parts of the Channel on Sunday. Temperatures have been rather high recently, the maxima reaching 70° and upwards, in places, since Sunday.

THE Weather Bureau of Washington, U.S., has issued, under the title of "Meteorological Work for Agricultural Institutions," a pamphlet containing suggestions as to observations and investigations regarding the relations of climate to agriculture which may with advantage be undertaken at stations situated in agricultural districts, as distinct from the work carried on at observatories and stations established in towns. These suggestions are equally useful for observers in any country; we therefore draw attention to some of the points referred to. (1) Problems of temperature; such as the differences that occur in quiescent air, between places that are close together. These differences depend on solar and terrestrial radiation, the covering of the soil, &c. The subject of protection from frosts also deserves further study. (2) Moisture in the air; especially measurements of evaporation, both from a water surface and from different kinds of soil. The transpiration of plants should also be measured, in such a way that the evaporation from a plant can be compared with the precipitation over the surface occupied by the plant. (3) Condensation and precipitation of moisture. An accurate record of the amount of dew is much wanted; at present, no observations are regularly made. A drosometer has, however, been recently constructed by Kappeller, of Vienna; it is described in the *Meteorologische Zeitschrift* of March last, and is said to give good results. Snow presents many features of interest, such as its density, and the relation of the character of the flake to the character of the weather at the time of the fall. The density of fog, also, should be recorded on some uniform plan, such as the distance at which a slender pole can be seen. The average size and usual forms of hail-stones should also be recorded. (4) Local weather predictions, independent of the daily weather charts, should be carefully studied. The special study of thunderstorms and other local disturbances will result in enabling them to be predicted several hours in advance. Systematic observation with the rain-band spectroscope should also be made. These are but a few of the questions raised in Prof. Harrington's interesting memoir.

WE have received from the Director of the Batavia Observatory (1) rainfall observations in the East Indian Archipelago, and (2) observations made at the Magnetical and Meteorological Observatory, Batavia, both for the year 1890. The daily and monthly rainfall values are given for 193 stations, together with the mean values, calculated from five or more years for 171 stations. The summaries show that the rainfall which accompanied the eastern monsoon was copious over the whole area, and that both in the years 1889 and 1890 the amount during the months of May to September was abnormally high in the eastern parts of the archipelago. In addition to the hourly meteorological observations for 1890, results for twenty-five years, 1866-90, are published in this volume. Dr. Van der Stok considers the fact proved beyond doubt that at Batavia the moon has an appreciable influence on the number of thunderstorms. The cloud curve also shows an increase of cloudiness as the moon rises above the horizon. After the moon has set, the cloudiness does not decrease at a continuous rate, but apparently remains constant.

WE have received the January number of the *Revista do Observatorio*, which is a monthly publication of the Observatory of Rio de Janeiro. This pamphlet, which, by the way, is an index number, contains in tabulated form all the meteorological observations made during that month at the several places from which regular observations can be obtained. The tables show the daily as well as the hourly reduced readings.

THE Technological Museum of Sydney was taken over by the Department of Public Instruction on January 1, 1890. In his first annual report, just received, Mr. J. H. Maiden, the Curator, says the public have shown their appreciation of the usefulness of the Museum by presenting it with a large number of objects, many of which are of great value. The authorities of the Museum have done excellent service by supplying lecturers with specimens, diagrams, and apparatus for illustrative purposes, and by answering questions sent to them by public school teachers—chiefly in country districts—on such matters as the naming of minerals and plants. Technological museums have been, or are being, formed in all those towns in New South Wales which already possess technical colleges. Mr. Maiden says that the matter has been taken up warmly in country districts, and that the formation of local collections is felt to fill up an important gap in the arrangements for technical education in the colony. A flourishing scientific society at West Maitland offered its valuable collection of natural history specimens to the Department of Public Instruction on condition that suitable accommodation should be found for them, and facilities given to the members for access to them. The specimens having been accepted by the Minister on these terms, they form a valuable addition to the West Maitland Technological Museum, constituting a natural history "side" to it. As local scientific societies are always likely to be useful in securing specimens for local museums, and in concentrating the scientific activity of a district to the advantage of the local technical college, and of the district in general, Messrs. Sach and Ross, the resident science masters at Goulburn and Bathurst respectively, have formed scientific societies in their respective cities. These societies have already a good number of members, who meet regularly for the discussion of scientific questions, and they seem to Mr. Maiden to give promise of much usefulness.

At the meeting of the Linnean Society of New South Wales on March 30, Mr. R. Etheridge, Jun., read a paper on, and exhibited, a very peculiar form of "womerah." It is from an unknown locality, but its history is partially known, and a clue is furnished by three very similar weapons in the Macleay Collection from Port Darwin. It is lath-like in form, slightly curved in outline, and altogether a remarkable implement, very unlike anything, to the author's knowledge, previously described.

Dr. G. T. Stevens publishes in *Science* of May 6 an interesting preliminary note on the relations of the motor muscles of the eyes to certain facial expressions. He has for some years closely observed the anomalies of the muscles which govern the movements of the eyes, and has been struck by the fact that remarkable changes often follow the modification of the conditions of these muscles. This led him not only to regard such facial changes with greater care, but to bring to the subject the aid of photography, by means of which alone the expressions could be accurately registered. Photographic portraits giving a direct front view of more than two thousand persons have thus been made. In each case a record, as full as he has been able to obtain, of the state of the eye muscles has been made, and in the majority of cases careful observations have been repeated many times during some weeks or months. Photographs have been taken at various stages of modification of these muscles, so that a comparative study of the face under varying conditions of the eye muscles has been rendered possible. The result of the investigation has been to demonstrate that "certain well-defined types of facial expression are not only associated with, but are dependent upon, certain relative tensions of the oculo-motor muscles." The object of his paper is to present the general characteristics of some of the most typical forms of expression which have their origin in efforts to adjust the eyes.

The first part of a paper on the development of American armour-plate, by Mr. F. Lynwood Garrison, appears in the May number of the Journal of the Franklin Institute. It was the author's original intention to present in the form of a report the results of the recent armour-plate trials at Indian Head. As, however, these trials have been described in an excellent report by the Chief of the Bureau of Ordance of the U.S. Navy, Mr. Garrison has preferred to give a sketch of the development of armour-plate, combining with this the more important details of the official report. He writes from the standpoint of the metallurgist rather than that of the military engineer. At present great interest is centred upon the use of the complex steel alloys and the methods adopted to harden them, and it is to these subjects more particularly that he calls attention. The detailed methods of producing such alloys as well as the several methods for quenching and tempering armour-plate are kept secret by steel manufacturers; but the results are made public at the trials, and "the possible deductions to be made therefrom," says Mr. Garrison, "are patent to every observing and thinking engineer." The fact that he has had exceptionally good opportunities of making such observations is a sufficient reason for the publication of his views.

Some interesting details as to the production of mercury in Russia have been submitted by Prof. Emile Muller, of Taschkent, to the Paris Geographical Society. A bed of this rare metal, discovered at Ekaterinoslav, is now worked with great energy, and 20,000 pouds (320,000 kilogrammes) of pure mercury are obtained. The entire demand for the metal in Russia is supplied from this source, and a surplus of 14,000 pouds (224,000 kilogrammes) is exported. During the past year mercury was discovered in the district of Daghestan, in the Caucasus, and it is expected that the discovery will lead to the growth of a profitable industry in that region.

The vine industry in Bashahr, in the Punjab, was formerly of great importance; but of late years it has declined in consequence of the old trees having been attacked by a disease. Mr. Coldstream, the Deputy Commissioner of Simla, proposes to revive the industry, if possible, and has secured a large number of cuttings for the State.

The *Pioneer Mail* (Allahabad) of May 5 says that locust swarms are reported from the frontier, and that stragglers have been observed again passing over Lahore. It is thought that they have chosen a bad time, as the district is full of the migratory hosts of starlings which come at this season of the year to feed upon wild mulberries, and few of the stragglers are likely to "run the gauntlet" successfully.

The additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Mr. M. McPherson; a Crested Porcupine (*Hystrix cristatus*) from Africa, presented by Mr. J. Bullock; a Common Pea-fowl (*Pavo cristatus*) from India, presented by Colonel Bagot Chester; two Yellow-bellied Toads (*Bombinator bombinus*), European, presented by Mr. A. M. Ansler; two Black Bears (*Ursus americanus*) from North America, deposited; a Japanese Deer (*Cervus sika* ♂); a Bennett's Wallaby (*Halmaturus bennetti* ♀); two Himalayan Monauls (*Lophophorus impeyanus*); two Greater Black-backed Gulls (*Larus marinus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

Paris Observatory Report.—The annual report on the state of the Paris Observatory for the year 1891, presented by Admiral Mouchez, shows that a considerable amount of work, as in former years, has been accomplished during the past year. After mentioning briefly some of the last reports that have been communicated by those who are undertaking the work of photographically charting the heavens, he gives a *résumé* of the resolutions that have been adopted during the session of 1891. In the table showing the zones allotted to the different Observatories, that given to Greenwich lies between declinations + 90° and + 65°, and that to Oxford between + 31° and + 25°; the number of plates for each zone being 1149 and 1180 respectively. A *résumé* of the meridional observations for the year informs us that no less than 19,458 observations were made, while those of the planets amounted to 570. M. Paul Henry, M. Wolf, and M. Deslandres, have all been busily engaged in their respective sections, their work having been previously mentioned in these columns. The second volume of the catalogue and the second volume of the observed positions (6h. to 12h.) have been completed and published; while Part III. (12h. to 18h.) is still in preparation. The observations for 1884 are now quite finished, and those for 1885 will be ready by the end of this year. The verification of the reduction of the observations made in 1884–86 for the formation of a catalogue of twenty-four stars very near the Pole has already been commenced, and should, when completed, form a most important volume. The individual works that have been published from time to time are also referred to here. The meteorological observations and time service have been continued as usual.

Stars with Remarkable Spectra.—No. 3090 of the *Astronomische Nachrichten* contains a list of stars with remarkable spectra, continued from a former number (3023) of the same periodical, and communicated by T. E. Espin. The number of spectra described here is no less than 121, and the star places have all been brought up to the year 1900.

Comet 1892 Swift (March 6).—The ephemeris of this comet for this week is as follows:—

1892.	R.A. h.	m.	s.	Decl. °	′	log Δ.	log *r*.	Br.
May 27	23	43	17	+35	36·6			
28		45	36	36	2·2			
29		47	54	36	27·4	0·1727	0·1297	0·42
30		50	10	36	52·1			
31		52	24	37	16·2			
1		54	36	37	39·9			
2		56	46	38	3·2	0·1821	0·1429	0·38

The brightness at the time of discovery is taken as unity.

On the 30th the comet will lie in the prolongation of the line joining v and θ Andromedæ, being about twice the distance from θ as is σ.

Light Variations of Y Cygni.—In *Astronomische Nachrichten*, No. 3091, Prof. Dunér discusses the results of his observations, made during the interval April 1891 to April 1892, of Y Cygni, with respect to the cause of the anomalies in the light variations. The number of minima observed amounted to twenty-seven, and on their reduction (together with many others), by grouping the differences between observation and calculation in a particular way, the values for the normal deviations were obtained. These figures showed that the even and odd epochs deviated on the positive and negative sides respectively; and from subsequent calculation, in which $\pm z$ represented constant deviation of the even from the odd minima, the numerical value of z was found not to be constant, but a slowly-increasing quantity. Mr. Yendell, who has previously considered this question, explained the possibility of representing such differences by a periodical function, but Prof. Dunér, assuming a systematic difference between the even and odd epochs, explains them otherwise—"that the star Y Cygni consists of two equally large and bright components, which revolve around their common centre of gravity in an elliptic orbit with a period of revolution of 2d. 23h. 54m. 44s.; the perihelion passages occurring between the even and the odd epochs." If the value of z be found to be real, and not as at present only suspected, we might suppose "a third body, dark or only slightly luminous, which should cause a perturbation in the position of the lines of apsides, such as we recognize in the planets and satellites of our solar system."

To facilitate observation, Prof. Dunér gives an ephemeris for the times of minima expressed in Greenwich mean time. From the latest observations these times may be probably half an hour too late.

Epoch.		Minimum.	d.	h.	m.
1341	1892	June	9	9	33
1361		July	9	8	40
1381		August	8	7	46
1401		September	7	6	52
1421		October	7	5	58
1441		November	6	5	5
1461		December	6	4	12

Nebulæ.—The *Monthly Notices* for April contain some notes on observations of nebulæ made by Mr. Burnham with the 36-inch refractor of the Lick Observatory. The work was undertaken by him during the months of September and October, 1891, in order to give fuller details concerning the descriptions, places, and actual existence of several of these objects included in the general catalogue. All the places derived from the measures are referred to the epoch 1860 of the general catalogue, while the numbers used in all cases are those of Dreyer's general catalogue.

During this survey, several new nebulæ were found, although no attempt was made to search for new objects. The following list includes some of these, together with some of the doubtful nebulæ:—

No. 707.—R.A. 1h. 44m. 31s., Decl. −9° 12′·0. In the immediate vicinity of this a new nebula was found, R.A. 1h. 43m. 31s., Decl. −9° 13′·4.

No. 874.—R.A. 2h. 9m. 43s., Decl. −23° 50′·5. No nebula found near this place. Probably a faint star had been seen, as many are near this position.

No. 942.—R.A. 2h. 21m. 30s., Decl. −11° 27′·2. Near this position are three fainter nebulæ, two of which have been observed before, but one quite new. The places for these three are Neb. (*a*) (new) 2h. 22m. 0 5s., Decl. −11° 27′·9; Neb. (*b*) 2h. 22m. 23·5s., −11° 28′·1; and Neb. (*c*) 2h. 22m. 22·7s., −11° 27′·6.

No. 988.—R.A. 2h. 28m. 34s., Decl. −9° 57′·9. No suggestion of any nebulosity about this star after very careful scrutiny.

Barnard.—R.A. 5h. 14m. 33s., Decl. + 3° 20′·7. In sweeping for this double nebula, another nebula was found in the immediate vicinity, R.A. 5h. 14m. 40s., Decl. + 3° 10′·4.

No. 1988.—R.A. 5h. 29m. 4s., Decl. + 21° 7′·7. Not the least trace of nebulosity here. Dreyer stated that Tempel pointed out that supposed nebula was only a false image of the star. New observation endorses this view.

No. 7447.—R.A. 22h. 53m. 6s., Decl. −11° 16′·7. This object certainly does not exist.

No. 1086.—Near this nebula are two others—

Neb. I. 2h. 40m. 49s., Decl. + 40° 28′·5.
Neb. II. 2h. 41m. 12s., Decl. + 40° 28′·6.

ANNIVERSARY MEETING OF THE ROYAL GEOGRAPHICAL SOCIETY.

The anniversary meeting of the Royal Geographical Society was held on Monday afternoon, when the Right Honourable Sir Mountstuart E. Grant Duff was re-elected President. The following changes have taken place amongst members of the Council:—Sir Henry Rawlinson and Mr. Clements R. Markham have been appointed Vice-Presidents in the room of Sir Frederick Goldsmid and Sir Beauchamp Walker, both of whom remain on the Council, Sir Beauchamp Walker being appointed Foreign Secretary in place of the late Lord Arthur Russell. In addition to the Councillors who have been elected Vice-Presidents, the following have retired by rotation:—Sir George Bowen, Dr. R. N. Cust, Sir Alfred Dent, the Duke of Fife, and General Maclagan. In their place Lieut.-Colonel J. C. Dalton, Sir Arthur Hodgson, Mr. John Murray (the publisher), Mr. E. G. Ravenstein, Sir Rawson Rawson, and Colonel Tanner have been elected.

During the meeting the Royal Medals for the Encouragement of Geographical Science and Discovery were presented, the Founder's Medal being given to Dr. Alfred Russel Wallace in recognition of the high geographical value of his great works, "The Geographical Distribution of Animals," "Island Life," and "The Malay Archipelago," and his further claim for distinction as co-discoverer with Darwin of the theory of natural selection. The Patron's Medal was presented to Mr. Edward Whymper for the results of his journey in 1879–80, recorded in his work, "Travels among the Great Andes of the Equator," London, 1892, 2 vols., besides a volume on the aneroid barometer. The Murchison Grant for 1892 went to Mr. Robert Swan, surveyor and geologist, who accompanied Mr. Bent in his expedition to Mashonaland, making a careful route-map of the country traversed down to the East Coast at Beira; the Back Grant to the Rev. James Sibree, for his many years' work on the geography and bibliography of Madagascar; the Cuthbert Peek Grant to Mr. Charles W. Campbell, for his important journeys in Korea; and the Gill Memorial to Mr. G. H. Garrett, for important geographical work done during the past fifteen years in Sierra Leone. Mr. Mackinder and Mr. Buchanan gave a short account of the Geographical Lectureships at Oxford and Cambridge. The scholarships and prizes given by the Royal Geographical Society to students in training colleges for 1892 were also presented.

The President delivered the annual address on the progress of geography, in the course of which, after referring to the evening meetings and to the Proceedings for the past year, he said:—

'With our meetings all Fellows of the Society who live in London, and with our Proceedings all Fellows of the Society, may be taken to be more or less familiar, but our Fellows by their contributions do a great deal more for their science than to make it possible to hold meetings and to publish Proceedings; nor does it seem unadvisable to remind them, from time to time, what they are doing in other ways for science and the body politic. They are aware that an annual vote of £500 is taken in the Estimates in aid of the Society's finances. In return for that it is bound to keep open for the public at large, and does keep open, a map collection of great importance. During the last year some 2500 persons visited the map room, which is in charge, as you all know, of Mr. Coles, a most competent officer; but if we had more room we could be much more useful. We could, for example, store, in such a way as to make it quite easy to refer to them, all the 25-inch Ordnance Survey maps. That at present is perfectly out of the question. We should like also, if we had the space, to have a room where any Member of Parliament or person holding an official position could at once be supplied with all the information he could desire upon any of the innumerable questions where politics and administration cross the frontiers of geography.

"Another of our duties is to collect and keep together a large collection of books, maps, diagrams, photographs, and other helps to earth-knowledge. Of the first of these we have about 40,000, valued at not less than £10,000. Of the second and third, about 50,000 maps and charts and 7000 atlases; and of the fourth about 4000 copies, together valued at about £8000. We keep, too, a stock of instruments, which we lend from time to time to travellers who satisfy us that they can use them; £680 worth of these have been lent to Government officials since 1888. A further department of our activity is map-making. We have recently produced a large-scale map of East Central Africa, as well as maps of Persia and Tibet, edited respectively by Mr. George Curzon and General J. T. Walker, while we are constantly publishing in our Proceedings original maps which, but for us, would never see the light at all, or, if they did, only after an amount of delay which would greatly impair their usefulness.

"The same officer who presides so well over our map collection renders very useful services to the public, by giving instruction in surveying and practical astronomy to persons who are going into countries the geography of which is little known. Forty-eight servants of the Government, soldiers, sailors, and others, of whom twenty-one were employed on special service and boundary commissions, have recently taken advantage of this teaching. We receive too as students, at the desire of the Colonial Office, all officials who come to us before going out to West Africa, and pay half their fees, while our advice and help is always at the disposal of any of the Government Offices which desire to consult us on the choice and purchase of instruments.

"Another very important function which our Fellows enable the Council to fulfil, is the granting of direct subventions to intending explorers, and you all know what large sums have been given at various times for such purposes. Mr. Conway, a most experienced mountaineer, and a man of large scientific knowledge, started in the beginning of this year to explore the glaciers of the Karakorum. He received from us £250 towards his expenses, and a conditional promise of more.

"To Mr. Pratt, who read at one of the Society's meetings a very valuable paper on North-Western China more than a year ago, and who is now going through the regions, first clearly revealed to science by Mr. Bates in his delightful "Naturalist on the Amazons," to explore the still unknown or little known regions in the extensive valley of that great river, we have given a grant of £100, and have lent him instruments. If he adds considerably to geographical knowledge, our contribution may be increased at a later period. We have given a small grant in aid of a proposed inquiry into the Houssa language and people. To Dr. Nansen we have voted £300. The object of his expedition, it should be remembered, is not so much to reach the North Pole, as to explore the unknown Arctic region. This he proposes to effect, not by following the coast line of Greenland or Franz Josef Land, which might be the best plan *if* their coast lines extend much beyond the points already known; but to reach the edge of the hitherto untravelled region by the help of the surface currents which he believes cross the Polar region from Siberia towards Greenland.

"In the beginning of the year we published a circular prepared by the Orthographical Committee of the Council upon the spelling of geographical names. This was done in pursuance of the policy announced in the Proceedings for 1885, p. 535—a policy in which we were encouraged by observing that the charts and maps issued during the last six years by the Admiralty and War Office have conformed to our views; that the Foreign and Colonial Offices have done the same, and that the Government of the United States of America has adopted a very similar system.

"The death of Mr. Bates rendered vacant the office of Assistant Secretary, and the Council felt sure that it would consult the best interests of the Society by promoting to that position our late librarian, Mr. Keltie, who was made at the same time editor of the Society's publications. The vacancy caused by this promotion was filled after a very careful consideration by the appointment of Dr. H. R. Mill, who has done much already for scientific geography. Our cartographical department has been strengthened by the accession of Mr. Darbishire, a highly promising pupil of Mr. Mackinder's at Oxford, who has also had an excellent German training.

"The Council has requested three gentlemen, well known to the Society, to represent it at one or other of the Congresses to be held at Madrid, in the neighbourhood of Huelva, and at Genoa, in honour of the fourth centenary of the discovery of America by Columbus. The attention of many I address was doubtless called to the Congress at Berne, where, by the way, England 'was conspicuous by its absence' in the Educational Section. A strong wish was expressed there that the next Congress should meet in London, and the necessary steps have been taken to comply with that wish. A committee, of which Major Darwin is the head, is now engaged in initiating arrangements for a Geographical Congress to be held in 1895.

"Hardly inferior in importance to the duty of assisting well-considered exploration and supplying true explorers with an audience to applaud their discoveries—a duty laid upon the Society by all its past—is the duty laid upon it by the necessities of the present to assist in the wider diffusion of geographical instruction.

"In our attempts to increase the amount and improve the quality of geographical teaching in the country we had to put up with some grievous disappointments. We began as far back as 1869 by giving medals to be competed for by the principal English schools. Two schools, and two only, distinguished themselves in the competitions—Dulwich College and Liverpool College. As to the fourteen others, the less said the better. The Society, however, had no idea of allowing itself to be beaten by the *vis inertiæ* or *laches* of individuals. Mr. Freshfield, one of our honorary secretaries, himself an Etonian, was possessed with a perfect passion for giving to others the advantages in respect of geographical instruction which he had not enjoyed in boyhood. Mr. Bates, our late excellent assistant secretary, pondered long, as was his wont, as to whether we ought to throw a substantial portion of our strength into improving education, and having come to an affirmative conclusion, took the matter up with characteristic energy. The Council was of the same mind, and ere long it was determined—

"1. To send Mr. Keltie to report upon geographical teaching at home and abroad.

"2. To open, under the auspices of the Society, an Educational Exhibition, in which all the best appliances for the teaching of geography should be brought together.

"Mr. Keltie accordingly commenced his investigations, travelling very widely while he carried them into effect. His Report was published, and excited much attention. The Exhibition was open during December 1885 and January 1886, and was visited by several thousands of persons interested in education. The collection contained in it has been lent to the Teachers' Guild, and is now exhibited in the museum of that body in Gower Street.

"The movement thus inaugurated resulted in various changes in our policy. We concluded a treaty with the University of Oxford in 1887, and with Cambridge in 1888, by which it was stipulated that we should go shares with each of these learned bodies in paying the salary of a lecturer to teach geography to such of their members as choose to avail themselves of his services. An argument, if it deserves the name, has sometimes been advanced, to the effect that we should not teach geography at our Universities, 'because it is a graphy and not a logy!'

"Throughout Germany the question has been settled. In that country, as well as in Austria and elsewhere, professors of geography are lecturing, and lecturing to excellent purpose, without interfering either with the domain of their historical colleagues on the one side or their geological colleagues on the other. Whether it is taught or not taught in schools and Universities, geography must in the nature of things rule the territory in which the sciences relating to organic life, from history down to the structure of the humblest animate thing, meet the sciences which have to do with inorganic nature.

Call it a 'graphy,' or a 'logy,' or a 'Kunde,' or what you please, it remains the body of knowledge which has to do with the theatre of the activity of man and all things that have life. We may stunt and injure the activity of the next generation by refusing to teach it, but eventually it must obtain the position which the greatest of living systematic botanists claimed for it in 1886. 'It must permeate,' he said, 'the whole of education to the termination of the University career, every subject taught having a geographical aspect.'

"When, in spite of foolish objections, we had sown the seeds of what we may hope, having regard to the slowness with which trees grow in our English climate, to be vigorous saplings about the end of the century and respectable denizens of the forest in the year 2000, we turned to the training schools, and concluded a convention with the Education Department, whereby we engaged to give certain scholarships and prizes to such of their students as were reported by the Inspectors of Schools charged with the conduct of the examinations to be worthy of those distinctions. Then, further, we entered into arrangements in 1888, with the directing Delegates of the Oxford University Extension Lectures, by which we agreed to give, on certain conditions, a yearly grant of £60, in aid of geographical teaching. We have resolved to set on foot regular courses of geographical lectures in London, which will commence probably next November, and be given by Mr. Mackinder and other competent geographers.

"Our very latest measures for the improvement of geographical education have been :—

"1. To agree to some modifications in the distribution of the prizes to the training colleges which the officers of the Education Department advised, and which will better promote the object which the Society has in view.

"2. To co-operate with the Manchester Geographical Society in assisting the governing body of the Victoria University to introduce geographical teaching into the curriculum by making a substantial grant for that purpose.

"3. To award a travelling scholarship of £100—our share being £50—after an examination held at Oxford. This was gained by a young man, Mr. Grundy, who was bound, under the conditions prescribed, to travel for at least three months in one of a number of districts from which he might take his choice, and communicate the results to us. He has selected Bœotia, and will, I make no doubt, furnish the Society ere long with some valuable information.

"We continue the prizes given at the Oxford and Cambridge local examinations, and to the boys of the training ships. These belong to the same period of our history as the Public School medals, but with them we have been more successful. We are in correspondence with the Scotch Education Department as to the best method of further encouraging geographical study on the other side of the Tweed, where it has long been comparatively popular.

"It seems to me quite certain that this part of our activity will fill a larger and larger space in the thoughts of all of us for a long time to come. The day will arrive when it will be of very little importance. Common-sense has a way of conquering in the end, and the proposition that it is highly desirable for intelligent creatures inhabiting this planet to have a good general notion of the opportunities which it affords them is so self-evident, that one would think it did not require a very numerous and powerful Society to urge its general acceptance upon the scholastic world.

"Geography and history are relegated to a subordinate place in almost all our schools which consider themselves to belong to the first or second rank, while the utmost prominence is given, not to reading the classics, to getting thoroughly imbued with classical ideas, and to having the mind filled with whatever of good and great the ancient world has bequeathed to us, but largely to accomplishments in the way of turning out pretty pieces of verse or prose, in the ancient tongues, which bear much the same relations to serious intellectual pursuits as do to the proper works and ways of an intelligent dog the art of jumping through a hoop filled with paper, or that of balancing on his nose a piece of biscuit till he is told that it is 'paid for.' Educators who have given the best years of their lives to these accomplishments naturally abhor the idea of diminishing their importance, and when they are asked to find a reasonable place for history and geography in their schools they piteously point to their time-tables and say, 'How are we to manage it?' Manage it by the elimination of rubbish. Put composition in the ancient tongues as a piece of regular 'school business' behind the fire, and greatly diminish the amount of time given to learning by heart in the interest of Latin and Greek composition. Neither geography nor history will ever obtain their proper position in education until we can get rid of the superstition as distinguished from the religion of the classics. No reasonable man who has a competent acquaintance with the subject can tolerate the idea of the classics being neglected. They form a most important part, and must always continue to form a most important part of literature, and literature is for a large class of minds a most excellent training. For a great many minds, however, it is not an excellent training, and to a considerable proportion of those susceptible of being trained by it the ancient languages present no attractions. I maintain that for a great many minds geography and history, well and carefully taught, would be much more educative than the two studies which as late as the time at which I took my degree, not quite forty-two years ago, almost absolutely monopolized attention in Oxford and Cambridge. Then, too, we must remember that while for everybody classics are mainly educative, and in a much less degree instructive, and while mathematics are instructive in a high degree only to those who are going into any of the no doubt numerous careers for which they are essential, geography and history are instructive in a very high degree to all, even to those to whom they are not educative.

"What I think we as a Society should keep chiefly in view is to try to have a clear and connected account of the leading facts which are known about the theatre of man's activity, together with an intelligent idea of the leading causes which have brought those facts about very much more widely extended through all ranks than they are now. We must keep our aims moderate in geography. There are undeniably a few persons to whom both geography and history, teach them as you will, are thoroughly abhorrent. Well, teach the very minimum of them to such people. A large number of people can be cultivated, and very highly cultivated, better through geography and history than anything else. All I ask for is, that in the education of such people these two sciences should play a very much larger part than they do now. I think that if we could see some thoroughly good hand-book of physical geography and another of political and commercial geography made part of the teaching of all secondary schools, and a subject of the leaving examination which should be borrowed from Germany, if we continue to hold up as we are doing at Oxford, and elsewhere, a very high standard of professorial teaching in our subject, while we at the same time persist in the other lines of educational activity to which I have alluded, we should have done a good deal ; but it is far from improbable that we may ere long see our way to giving further stimulus to sound geographical teaching in various parts of the country. The Society, however, may be assured that we will remember the maxim *Festina lente*, and not waste the resources with which its members supply us in any rash experiments. Geography is rooted in the physical sciences, and makes each of them tributary to her, while history which is not rooted in geography, and which does not learn from geography all it has to teach about the existing conditions of man's dwelling-place, is simply bad history."

The President then referred to the year's exploration. Herr Merzbacher's work in the Caucasus, and Mr. Howell's ascent of Oræfa Jökull in Iceland, were noticed as the chief mountaineering feats. In Asia military exploration had gone on steadily on the northern frontiers, and the Society was making efforts to have the results of such work made more accessible to the public. Lord Lamington's journey in the Shan States, Captain Bower's and Dr. Thorold's adventurous crossing of Tibet also opened up new ground. In Africa Mr. E. A. Floyer crossed the Egyptian Desert from Assouan to the Red Sea ; and in the region of the Great Lakes Captain Lugard, Emin Pasha, Dr. Stuhlman, and the late Father Schynse have added to our knowledge. The Italians have been energetic in exploring Somali-land, and the French, despite the disaster to M. Crampel, have not abandoned their efforts to reach Lake Chad from the west. Captain Gallwey and Mr. Gilbert T. Carter have made important discoveries in Lagos and Benin. Mr. Bent's well-known exploration of Zimbabwe, and Mr. Joseph Thomson's study of Lake Bangweola, which ill-health still prevents him from recording, are the most important pieces of work in South Africa.

The semi-Arctic regions of Labrador and Alaska have received much attention in America, and their topography is being more definitely ascertained.

In Australia the Elder expedition has unfortunately collapsed, after doing much good work, but Sir William MacGregor has been very active in opening up British New Guinea.

Reference was also made to the progress of the hydrographic surveys in different parts of the world.

In the evening the anniversary dinner of the Society took place at the Whitehall Rooms, Hôtel Métropole, and was attended by a large gathering of Fellows, with many of the leading scientific men and members of the Diplomatic Service as guests. The President occupied the chair. A clever speech was delivered by Mr. Whymper, in response to the toast of "The Medallists." Mr. Bryce, Colonel Maurice, Prof. Flower, Mr. W. T. Thiselton Dyer, and Mr. Norman Lockyer responded to the toast of "The Allied Sciences and Sister Departments."

TRANSFORMERS.[1]

ALTHOUGH transformers are in constant use for changing alternating currents of electricity from high to low or from low to high potential, exact calculations concerning them have hitherto been looked upon by scientific men as impossible because of the complicated law of magnetization which must subsist in iron. Calculations on the assumption of constant magnetic permeability were thought to be worthless, therefore, although these were the only ones which could be made. Certain graphical methods of representing what occurred were, however, based upon the constant permeability hypothesis, and although such graphical methods could only be useful in illustrative work, they were thought to be accurate enough when great accuracy was impossible. The absence of a theory was supplied by vague statements regarding the effects of hysteresis; and the cycle of magnetization being supposed to be exactly the same, however rapidly performed, and Foucault currents being ignored, it was possible for any writer to get his literature on this subject published and read and commented upon.

Prof. Perry has for a long time preached the doctrine that the only theory of the transformer that can be carefully worked out—namely, that in which hysteresis is ignored—ought to be worked out and compared with experimental results; and he insisted that when the known phenomena of magnetic leakage and slight saturation and Foucault currents are taken into account, the results of this theory explain all observed experimental results.

In the present paper he takes up the general case of a transformer with many primary and secondary circuits with magnetic leakage, Foucault currents, choking coils and condensers in series with or in parallel to any or all the circuits. He clears away much of the old difficulty by proving that, in all calculations except that of the idle current supplied to an unloaded transformer, in all practical cases, exactly the same answers are obtained, to four significant figures or more, whether we assume the most complicated of hysteresis cycles or whether we assume the very simplest, which is that of constant permeability. It is, for example, interesting to observe that a formula never hitherto published as correct, often enough used by manufacturers as sufficiently correct for practical purposes, is really a very correct formula. It is also shown that the mathematical difficulties introduced by condensers and magnetic leakage efface themselves completely now that the complete problem has been attacked, and that the numerical working out of the most complicated cases is a very simple matter.

The one problem on transformers in which it is necessary to consider the law of magnetization of the iron—namely, the calculation of the idle current when the transformer is unloaded—is solved by the author in general terms, and he gives a simpler solution, which in his opinion agrees with all experimental results, although it assumes that there is no hysteresis in the iron.

SCIENTIFIC SERIALS.

THE only important paper in the *Nuovo Giornale Botanico Italiano* for April is an elaborate one by Signor G. Paoletti on the movements of the leaves of *Porlieria hygrometrica*. The structure of the plant is described in detail, and especially the anatomy of the "motor nodes" of the leaves and of the leaflets. He distinguishes in them two kinds of tissue, a motor system and a passive system. The cause of the movements appears to reside in the protoplasm and in the osmotic properties of the cell-sap. The author is unable to find in the leaves any hygrometric properties, the supposed presence of which was the reason for the specific name of the plant. The paper is illustrated by four plates.

THE greater number of the papers in the 2nd, 3rd, and 4th numbers of the *Bullettino della Società Botanica Italiana* for 1892 are chiefly of local interest to Italian botanists. Among those of a wider scope are the following:—Signor L. Macchiati describes an appearance presented by *Navicula elliptica*, which he considers strongly to confirm Castracane's view of the occasional reproduction of diatoms by internal germs.—Signor P. Pichi gives the results of experiments on the power of the vine to absorp sulphate of copper through the roots as a specific against the attacks of *Peronospora*. Analysis of the ash showed the presence of copper in leaves taken from both the upper and the lower branches.—Signor L. Piccioli gives some details respecting the destruction of plants by different kinds of land and freshwater snails, with the amount which is devoured of different plants. This is generally greater in the spring than in the summer.

IN the *Botanical Gazette* for April, Mr. G. E. Stone describes and figures a self-registering auxanometer, which can be readily constructed, of much simpler construction than those at present in use in botanical laboratories.—Mr. Conway Macmillan offers suggestions as to the classification of the Metaphyta, *i.e.* of the higher forms of vegetable life.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 28.—"On some Phenomena connected with Cloudy Condensation." By John Aitken, F.R.S., F.R.S.E.

This paper is divided into two parts. In Part I. are described the different influences which cause the condensation of a jet of steam when mixing with ordinary air to become more dense than it generally is, and in Part II. certain colour phenomena are described which have been observed when cloudy condensation is made to take place under certain conditions.

PART I.

Steam Jets.

It had been previously shown that when a jet of steam is electrified the condensation suddenly becomes very dense. In addition to electrification, it is found that this change in the appearance of the jet may be produced by other four causes. There are thus five influences capable of producing the dense form of condensation. These are: 1st, electricity; 2nd, a large number of dust particles in the air; 3rd, cold or low temperature of the air; 4th, high pressure of the steam; and, 5th, obstructions in front of the nozzle, and rough or irregular nozzles.

1st. *Electrification.*

It is shown that the mere presence of an electrified body has no influence on the steam jet. In order to produce the increased density the water particles in the jet must be electrified, either by direct discharge, or by an inductive discharge, effected by means either of a point or a flame.

The increased density produced by electrification is due to an increase in the number of water particles in the jet, by the electrification preventing the small drops coming into contact by their mutual repulsions, in the same manner as the water drops in Lord Rayleigh's experiments with water jets, which scatter more when electrified than when not electrified. The coalescence of the drops in water jets takes place only under the disturbance produced by the presence of an electrified body, while such a disturbance produces no effect on steam jets.

Other experiments point to the conclusion that the increase in the density is due to an increase in the number, and not to an increase in the size, of the drops. For instance, if steam is blown into a receiver full of air in which there are many nuclei, the condensation is dense, and, if there are few nuclei, the clouding is thin. The same holds good for the clouding produced by expanding moist air. If many dust particles be present, the clouding is dense; if few, it is thin. The action of the electricity does not seem to be positive, as it has no effect on a mixture of hot moist air and cold air. It seems rather to prevent something which takes place in the jet under ordinary conditions. The particles in a jet being in rapid movement, there are frequent collisions, and consequent coalescence of the drops, but when the particles are electrified they repel each other, and coalescence is prevented.

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[1] Abstract of a paper read at the Royal Society, May 12, by Prof. Perry, D.Sc., F.R.S.

The jet on becoming dense emits a peculiar sound, which is the same whatever be the cause of the increased density. But, when electrified, along with this sound there is another, due to the discharge of the electricity, which causes the electrified jet to appear to make a louder noise. The jet, instead of changing suddenly in appearance when electrified, may be made to change very gradually, either by electrifying it by means of a very sharp point, or by aiding the discharge by a flame. Under these conditions, the jet emits only the sound produced when dense from any of the other causes.

2nd. *A Large Number of Dust Particles in the Air.*

Flame has not been found to have any influence on the steam jet, but on bringing the products of combustion to the jet, it at once becomes dense, and remains dense so long as the supply is kept up, and the jet has exactly the same appearance as if electrified. When in this condition electricity does not increase its density any further. The increased density is here due to the large number of dust nuclei, causing a great increase in the number of water drops, and these being very small, they will have less independent movement, and therefore fewer collisions, and the reduction in number from this cause will therefore be very slight.

3rd. *Low Temperature of the Air.*

When a steam jet condenses in air at ordinary temperatures it has but little density, but, if the open end of a metal tube cooled to 45° be held near the origin of the jet, the condensation at once becomes dense, and neither electrification nor an increased supply of nuclei makes it any denser. In a room at a temperature of 46° the jet is always dense, and neither electricity nor the products of combustion have any effect on it, but when the temperature rises to 47° the jet begins to get a little less dense, and electricity now increases its density slightly. At 50° the jet is much thinner, and both electricity and the products of combustion have a marked effect on it. The change produced by the cold air cannot be entirely due to the lower temperature causing more vapour to be condensed, as the fall of temperature is slight, while the increase in density is great. The increased density is shown to be due to a change which takes place in the films of the small drops with the fall of temperature. When the temperature is above a certain point, the films have no repulsive action, and the drops coalesce on collision; whereas when cooled below a certain temperature the well-known repulsion comes into play and prevents coalescence. This was proved by repeating Lord Rayleigh's experiments with water jets. When the temperature of the water was over 160°, the drops had no tendency to scatter, and the presence of an electrified body had no influence on the jet. It was only when the temperature fell that the scattering began, and the electrical disturbance produced coalescence. The effect of the low temperature is the same as that of electrification: both of them prevent the water drops coming into contact, one by electrical repulsion, and the other by the repulsive action of the water films, and the result is the same—namely, an increase, or rather a prevention of the decrease, in the number of the particles, and a consequent increase in the density of the clouding.

4th. *High Pressure of the Steam.*

Below a temperature of 46° the jet is dense at all pressures, and as the temperature rises the density decreases, but the density may be made to return by increasing the pressure. The increased density of the high-pressure steam jet is due to an increase in the number of drops produced, (1) by the jet being more cooled by the greater amount of air taken into it; (2) by a larger supply of dust nuclei; and (3) owing to the rate at which the condensation is made to take place, a larger number of dust particles are forced to become centres of condensation.

5th. *Rough Nozzles and Obstruction in Front of the Nozzle.*

Rough nozzles and obstruction in front of the nozzle are found to act in the same way as increase of pressure: they aid pressure in producing its effects with a less velocity of steam. They act by producing eddies, which mix more air with the steam, so lowering the temperature of the jet, increasing the number of dust nuclei, and quickening the rate of condensation.

The seat of sensitiveness to all these influences causing the condensation in the jet to become dense is near the nozzle. Both low temperature and obstructions have an effect only when they act very close to the nozzle; while electricity and increase in number of nuclei have a slight, but rapidly diminishing, influence to a distance of 3 or 4 cm. from the nozzle.

PART II.

Colour Phenomena connected with Cloudy Condensation.

The manner in which cloudy condensation changes after it is formed is pointed out, and it is also shown that the number of dust particles which become centres of condensation depends on the rate at which the condensation is made to take place, slow condensation producing few water particles and thin clouding, while quick condensation produces a large number of water particles and dense clouding. It is only when the dust particles are few that all of them become active centres of condensation.

Colour Phenomena in Steam Jets.

Colour has been seen by Principal Forbes and others in the steam escaping from engine boilers, but these colour phenomena have as yet been but little studied. For observing the colour in steam jets, the author has found it to be a great advantage to inclose the jet in a tube, and examine the effect through some length of condensing steam. Steam by itself has no colour in moderate lengths, but when mixed with a certain amount of cold air, and a certain quantity of dust, very beautiful colours are produced. A jet of steam is allowed to blow into the open end of a tube, and the amount of dusty air entering with it is regulated to the necessary amount. When the jet is condensing under ordinary conditions, the colour of the transmitted light varies from greens to blues of various depths, according to the conditions. The colour may be made very pale or extremely deep by varying the conditions. If the condensation in the jet be made to change and become dense by any of the influences already mentioned, the colour changes, and generally becomes of a yellowish-brown.

This yellow colour, seen through steam when the jet is electrified, has been previously observed. It was thought that the colour was due to the electricity, and that the experiment explained the lurid colour of thunder-clouds. There does not, however, seem to be any connection between the electrification and the colour, as the transmitted light becomes of the same lurid hue when the jet is made dense by any of the other influences.

The yellow colours seen through steam are not generally so fine as the greens and blues, but when the density is due to high-pressure steam the yellow is very fine.

Colours in Cloudy Condensation produced by Expansion.

No colours had been previously seen in the light transmitted directly through the clouded air produced by expanding saturated air in a receiver. It was thought this was due to the slowness with which this process is generally made to take place in the expansion experiments. On arranging an experiment to make the rate of condensation quick, beautiful colours were seen on looking through the clouded air. An air pump was connected with a metal tube provided with glass ends. The capacity of the tube was small compared with the capacity of the receivers usually used in these experiments. When the air in the tube was suddenly expanded, the light passing through it became beautifully coloured, and the colour, and the depth of the colour, varied with the conditions. With few dust particles in the air, a slight expansion made the transmitted light blue; a greater expansion changed it to green, and then to yellow; and when the expansion was still further increased the colour changed, and a second blue made its appearance, followed by a second green and yellow. But, if very many particles were present, the same amount of expansion which produced the second yellow only gave a very deep blue. When it is desired to produce these colour phenomena on a large scale a vacuum receiver is used. This receiver is connected with the experimental tube or flask by means of a pipe fitted with a stop-cock. After a partial vacuum has been made in the receiver, the connection between it and the flask or tube in which the colours are to be shown is suddenly opened, when the colour-producing condensation is produced. These colour phenomena fade rapidly, owing to the differentiation which takes place in the water drops.

The spectroscope shows that when the light is blue there is a general darkening of the whole spectrum, but the absorption is greatest in the red end, and the red end is also much shortened. When the transmitted light was yellow, the blue end was cut out, and the yellow part was much the brightest.

The Cause of the Colour.

In the steam jet when the condensation is dense some of the yellow colour in the transmitted light is due to some of the particles being so small that they reflect and scatter the blue rays. This blue reflected light is polarized. The colours, however, seem in most cases to be produced in the same manner as the colours in thin plates; only a few of the colours of the first order or spectrum are visible, whilst those of the second and third orders are very distinct.

A "Green" or "Blue" Sun.

It is thought that these phenomena give the explanation of the "green" or "blue" sun seen in India and elsewhere in September, 1883, and also on other occasions. The eruption of Krakatão had taken place a few days before the green sun was observed in India. The volcano threw into our atmosphere a great quantity of water vapour, and a vast amount of dust, the very materials necessary for producing a green sun by small drops of water. Prof. C. Michie Smith's observations made in India show that there was a great amount of vapour present in our atmosphere at the time, and most observers frequently refer to a fine form of haze which covered the sky on the days the green sun was seen. It is therefore in the highest degree probable that, under the conditions existing at the time, this haze was greatly composed of water.

A New Instrument for Detecting Dust-polluted Air.

The colour phenomena produced when air is suddenly expanded has led to the construction of a new instrument for indicating roughly the amount of dusty pollution in the air. This instrument has been called a "koniscope," and it is hoped it will be found useful for studying sanitary questions. The instrument consists simply of an air pump and a tube provided with glass ends. The air to be tested is drawn into the tube, where it is moistened and expanded. The depth of colour seen on looking through the tube indicates the amount of impurity in the air. With about 80,000 particles of dust per cubic centimetre the colour is very faint; 1,500,000 gives a fine blue; while 4,000,000 gives an extremely dark blue. These colours are for an instrument having a tube half a metre long. By means of this instrument it is easy to trace the pollution taking place in our rooms by open flames and other causes. We can trace by means of it the pure and impure currents in the room, and note the rate at which the impurity varies.

May 5.—"The Potential of an Anchor Ring." By F. W. Dyson, Fellow of Trinity College, Cambridge. Communicated by Prof. J. J. Thomson, F.R.S.

In this paper the author develops a method of dealing with physical questions connected with anchor rings. He applies it

(1) To find the potential of a solid anchor ring at all external points. The result is obtained in a very convergent series of integrals, each of which may be reduced to elliptic functions. The equipotential surfaces are drawn, when the ratio of the radius of the generating circle to the mean circle of the ring is $\frac{1}{5}$, $\frac{2}{5}$, $\frac{3}{5}$, $\frac{4}{5}$, 1.

(2) The density, at any point, of a ring charged with electricity is found; and the charge is calculated.

(3) The velocity potential of a ring moving in an infinite fluid is found, the kinetic energy calculated, and a few cases of motion discussed.

(4) The annular form of rotating fluid is considered, and the form of the cross-section determined. The cross-section even for large rings is, roughly, of an elliptic shape; the minor axis being parallel to the axis of revolution of the annulus.

May 12.—"On the Embryology of *Angiopteris evecta*, Hoffm." By J. Bretland Farmer, M.A., Fellow of Magdalen College, Oxford. Communicated by S. H. Vines, M.A., F.R.S.

The germination of the spore and the development of the prothallium have been described by Jonkman,[1] who also observed the formation of the sexual organs. The antheridium is formed from a superficial cell of the prothallium, which divides by a wall, parallel to the surface, into an outer shallow cell and an inner cubical cell. The former, by walls at right angles to the free surface, gives rise to the cover-cells; while the inner one, by successive bipartitions, originates the antherozoid mother-cells.

The antheridia are distributed both on the upper and lower surfaces of the prothallium, and apparently without any approach to regularity, though they are somewhat more frequent on the lower surface. I may observe, however, that an antheridium may often occur on the upper surface immediately above an archegonium which has been fertilized.

The archegonia occur exclusively on the lower surface. Their development has been described by Jonkman, who also noticed the division of the neck canal cell, by a transverse wall, into two cells. The division is not, however, invariable, and in one preparation in which the protoplasm had shrunk slightly from the wall, I observed that the cell plate had not extended so as to completely partition the neck passage into two cells.

The oospore, after fertilization, speedily forms an ovoid cellular body, and although I was not so fortunate, owing to scarcity of material, as to see the formation of the earliest cell walls, their succession could be determined with tolerable certainty in the youngest embryo that I met with, consisting as it did of about ten cells.

The basal wall is formed, as in *Isoëtes*, at right angles to the axis of the archegonium. The next one in order of occurrence I believe to be the median wall, which can easily be distinguished, even in advanced embryos, as a well-defined vertical line.

The tranverse wall is much more indefinite, and early loses its individuality owing to the unequal growth of the various parts of the young embryo. The further cell-division is irregular, and to a far greater extent than is the case with the leptosporangiate ferns as described by Hofmeister and Leitgeb.

The anterior epibasal octants together give rise to the cotyledon; the stem-apex is formed, not as in the leptosporangiate ferns, from *one* octant only, but from *both* of the posterior epibasal octants, though one of them contributes the greater portion. The truth of this statement is seen on examining vertical sections through the embryo cut at right angles to the median wall, when a few cells on each side are seen to be clearly marked out, by their dense protoplasmic contents and large nuclei, as meristem cells. There is no single apical cell in *Angiopteris* from which all the later stem tissue is derived, and this fact is, without doubt, to be connected with the character of the apical meristem just described. The root is formed from one of the octants beneath the cotyledon, *i.e.* from an anterior hypobasal one, and is at first indicated by a triangular apical cell, which, in one fortunate preparation, showed the first cap cell. The other octant, together with the two posterior hypobasal octants (which together form the rudimentary foot), round off the base of the embryo. The root presents considerable difficulty in tracing the course of its development, as the apical cell, at no time very clear, is early replaced by two cells. Moreover, the root grows in a somewhat sinuous manner in the embryo, and the cells of its apex may easily be confounded with other triangular cells which occur irregularly scattered in the lower portion of the embryo. It finally emerges, not immediately beneath, nor yet exactly opposite, the cotyledon, but at a distance from it of between one-third and one-half of the circumference of the embryo. The difficulties attending the exact following of its growth, added to the scarcity of the material, have prevented my elucidating completely the details of development, but the important point, that, even before its emergence from the embryo, its apex contains a *group* of initial cells, occupying the place of the single one characteristic of other orders of ferns, can be regarded as established with certainty.

When the embryo has reached a certain size, it bursts through the prothallium; the root boring through below, whilst the cotyledon and stem grow through the upper surface. This manner of issuing from the prothallium at once serves to distinguish *Angiopteris* from those other ferns whose embryogeny is known, and probably the peculiarity of its growth may be reasonably connected with the direction and position of the basal wall which separates the root and short portions of the embryo.

Fresh leaves and roots speedily arise on the young plantlet the second leaf appearing just above the place of exit of the first root—that is, not quite opposite the first leaf. The third leaf rises between the first and second ones, and nearer the first than the second. Their roots observe the same rule of divergence as that which obtains in the case of the first root. The stipular structures, so characteristic of the Marattiaceæ, are entirely absent from the first two leaves, but appear in a well-developed condition on the third and all succeeding leaves.

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[1] "De geslachtsgeneratie der Marattiaceeën," door H. F. Jonkman.

"On the Shoulder-girdle in Ichthyosauria and Sauropterygia." By J. W. Hulke, F.R.S.

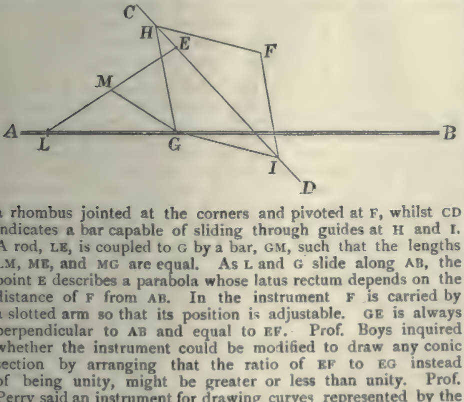
The author discusses the structure of the shoulder-girdle and the homologies of its several parts in these families. He shows that the alleged existence of a precoracoid in the Ichthyosauria rests on an insufficient foundation; offers proofs that in Plesiosauria the anterior ventral ray is not only theoretically but *actually* precoracoid; and also that the dorsal ray in the girdle *is* homologous with the shoulder-blade in Testudinata and other Reptilia.

"On the Development of the Stigmata in Ascidians." By Walter Garstang, M.A.

The author shows that the transverse rows of stigmata, which are present in all the fixed Ascidians, may arise in one or the other of two ways: either as independent perforations, distinct from the first (oozooid of *Clavelina*, buds of *Botryllus*); or as secondary formations, due to the subdivision of a series of primary transverse stigmata on each side (oozooid of *Botryllus*, *Styelinæ*). The former method of development is shown to be a modification of the latter.

The primary transverse stigmata (or "protostigmata") of *Botryllus* and the *Styelinæ* agree precisely with the definitive stigmata of *Pyrosoma* in structure, position, and order of formation. They are accordingly regarded as homologous formations; and the conclusion is drawn that *Pyrosoma* has not been derived from the fixed Ascidians, but represents an ancestral type of Caducichordate Tunicata, antecedent to the whole of the phylum Ascidiacea.

Physical Society, May 13.—Dr. E. Atkinson, Treasurer, in the chair.—Mr. R. Inwards read a paper on an instrument for drawing parabolas. It was designed for drawing curves of short focus such as are required for reflectors and for diagrams of the paths of comets and projectiles. Its construction is based on the fundamental property that every point on the curve is equidistant from the focus and the directrix. In the diagram below, AB is a slot representing the directrix, and FGHI a rhombus jointed at the corners and pivoted at F, whilst CD indicates a bar capable of sliding through guides at H and I. A rod, LE, is coupled to G by a bar, GM, such that the lengths LM, ME, and MG are equal. As L and G slide along AB, the point E describes a parabola whose latus rectum depends on the distance of F from AB. In the instrument F is carried by a slotted arm so that its position is adjustable. GE is always perpendicular to AB and equal to EF. Prof. Boys inquired whether the instrument could be modified to draw any conic section by arranging that the ratio of EF to EG instead of being unity, might be greater or less than unity. Prof. Perry said an instrument for drawing curves represented by the equation $y = x^n$ was greatly needed for engineering work.—Mr. F. H. Nalder exhibited and described some electrical instruments. The first shown was a ballistic galvanometer with one pair of coils, the distinguishing features of which were accessibility, small damping, great sensitiveness, and the arrangement of the control. The control is effected by a "tail magnet" carried on a horizontal tube supported by a pillar outside the case, as suggested by Prof. R. M. Walmsley. A small magnet on the cover serves for zero adjustment. The suspended system consists of four bell magnets, two being in the middle of the coil and one at top and bottom respectively, arranged so as to be astatic. The sensitiveness of the instrument shown was such that ¼ of a microcoulomb gave 300 divisions (fortieths of an inch) when the periodic time was 10 seconds and scale distance about 3 feet. Resistance of galvanometer about 10,000 ohms. To bring the needle to rest quickly, a damping coil mounted on an adjustable stand, and a special reversing key with resistances in its base, are provided. The key has successive contacts arranged so that when pressed lightly, only a weak current passes round the damping coil, whilst when pressed further a much stronger current passes. The strong currents are used to check the large elongations, and the weak ones for finally bringing to zero. A lamp-stand with semi-transparent scale arranged for use with a glow lamp was next shown. Instead of reading by the image of the filament, as is ordinarily done, the lantern is arranged to give a bright disk of light with a black line across the middle. Mr. Blakesley asked if the galvanometer was astatic. For damping non-astatic ones he had found it useful to wind several turns of wire round the bobbin, and put them in series with a few thermo-electric junctions warmed by the hand and a key. In reply, Mr. Nalder said the galvanometer was astatic, but the damping coil could be placed so as to act on one pair of magnets more than on the other. A paper on a portable instrument for measuring magnetic fields, with some observations on the strength of the stray fields of dynamos, by Mr. E. Edgar and Mr. H. Stansfield, was then read. The instrument was described as an inversion of a d'Arsonval galvanometer, for the torque necessary to maintain a suspended coil conveying a constant current parallel to the field gives a measure of the strength of the field. The constant current is furnished by a Hellensen's dry cell which the authors found remarkably constant. The instrument consists of a coil of about fifty ohms, wound on mica and suspended by two German silver strips within a tube. A pointer is fixed to the mica, and a divided head, to which the outer end of one strip is attached, serves to measure the torsion. Within the head chamber is a commutator which automatically reverses the current in the coil when the head is turned in opposite directions from zero. Two readings may thus be taken to eliminate gravity errors due to want of perfect balance in the coil. Means are provided for adjusting and measuring the tension of the suspensions. The constant of the instrument was determined by placing the coil in the field of a Helmholtz galvanometer, and found to be 0·293 per 1°. Any other field is therefore given by $0{\cdot}293\,(n + 1)\theta$, where θ is the angle of torsion in degrees, and n the multiple of 50 ohms in series with the coil. Fields from 2 or 3 C.G.S. lines upwards can be measured to about 2 per cent. by the instrument, and even the earth's field is appreciable. The authors have tested the fields of dynamos at the Crystal Palace Exhibition and elsewhere, and the results obtained are given in the paper. It is noted that the stray fields of multipolar machines fall off much more rapidly than those of two-pole dynamos as the distances are increased, and that near edges and corners of the magnets the fields are much stronger than near flat surfaces. The disturbing effect of armature reactions on the strength of the stray fields were measured, and the shapes of the fields observed in some cases. Experiments on magnetized watches are described in the paper. Mr. Whipple said the Kew Committee were to some extent responsible for the experiments described, for it was on their account that the investigations were commenced. In connection with the rating of so-called non-magnetic watches, it was necessary to know what strength of fields they were likely to be subjected to. The instrument devised for making the tests was a very interesting one, and the results obtained by it of great value. Mr. A. P. Trotter hoped the authors would supplement their work by tracing out the directions of the fields of dynamos, and he described a simple method of doing this by a test needle used as an india-rubber stamp. The question of watches, he thought, must be considered soon; even non-magnetic watches were stopped by being placed in strong fields, owing to Foucault currents generated in the moving parts. Mr. Blakesley inquired whether the instrument could be used in any position. He thought three observations would be necessary to completely determine any field. Mr. Stansfield, in reply, said they used a pilot needle for showing the directions of the fields, and then placed the coil accordingly. The instrument could be used in any position, for the weight of the coil was only about 2 grammes, and did not greatly alter the tension of the suspensions, which was usually about 300 grammes. A watch with a brass balance was not influenced by a field of 10 C.G.S. lines but seriously affected by one of 40.—Mr. Joseph W. Lovibond read a paper on a unit of measurement of light and colour. The paper was illustrated by many coloured charts, diagrams, and models, and several pieces of apparatus by which colour measurements could



be made were shown. The principle of the measurements depends on the selective absorption of the constituents of normal white light by coloured glasses (red, yellow, and blue). The depths of tint of the glasses are carefully graduated to give absorptions in numerical proportions. For example, two equal glasses, each called one-unit red, give the same absorption as a two-unit red, and so on. The units of red, yellow, and blue are so chosen that a combination of one of each absorb white light without colouring the transmitted light. Such a combination is called a "neutral tint unit." By the use of successive neutral tint units, white light can be gradually absorbed without showing traces of colour, and the number of such units required to produce complete absorption is taken as a measure of the intensity or luminosity of the white light. Methods of representing colours by circles and charts were fully dealt with, and the influence of time of observation on the penetrability of different colours was illustrated by diagrams. The results of 151 experiments on colour mixture were explained, and represented diagrammatically. After the reading of the paper the methods used for colour matching and measurement were shown by Mr. and Miss Lovibond.—Mr. R. W. Paul exhibited his improved form of Wheatstone bridge, arranged to occupy the same space, and fulfil the same conditions, as the well-known Post Office pattern.

Chemical Society, April 21.—Prof. A. Crum Brown, F.R.S., President, in the chair.—The following paper was read:—Masrite, a new Egyptian mineral, and the possible occurrence of a new element therein, by H. D. Richmond and Hussein Off. Masrite is the name assigned by the authors to a variety of fibrous alum obtained in Egypt by S. E. Johnson Pasha. It contains from 1 to nearly 4 per cent. of cobalt. This being the first occasion on which cobalt has been met with in Egypt, the authors were led to inquire whether the blue colour used in the paintings on Egyptian monuments contained that element. The samples obtained, however, owed their colour to compounds of copper and iron. The mineral is principally interesting on account of the presence in it of a minute quantity of a substance, the properties of which appear to be unlike those of any known element, which the authors provisionally term masrium, from the Arabic name for Egypt. From an analysis of the oxalate, on the assumption that it is a bivalent element, the atomic weight of masrium is calculated to be 228. The authors point out that there is a vacant place in the glucinum-calcium group of the periodic system for an element having the atomic weight 225. In many of its properties masrium resembles glucinum, and the oxalate is analogous to that of calcium. Masrite has the composition

$$(Al,Fe)_2O_3, (Ms,Mn,Co,Fe)O, 4SO_3, 20OH_2.$$

May 5.—Prof. A. Crum Brown, F.R.S., President, in the chair.—An extract was read from a letter to Sir H. E. Roscoe, written by Prof. Kühne, of Heidelberg, at the request of Prof. Bunsen, expressing his thanks for the address presented to him by the Chemical Society.—The following papers were read:—The existence of two acetaldoximes, by W. R. Dunstan and T. S. Dymond. Acetaldoxime, $CH_3 . CH : NOH$, has hitherto been regarded as a liquid capable of existing in only one form, attempts to obtain evidence of the existence of an isomeride having failed; the authors, however, find that it can be crystallized by cooling. The crystals so obtained are often several inches in length, and melt at 46°·5. On heating them to 100°–150° no decomposition occurs, and the substance boils constantly at 114°·5. If this heated liquid be now cooled, it does not crystallize until nearly 35° below the melting-point of the original substance, and the crystals so obtained become liquid at ordinary temperatures. Many similar observations have been made, and it has been invariably found that on heating the aldoxime the freezing-point is lowered to a greater or less extent. Evidence has in this way been accumulated, showing that a change in the constitution of acetaldoxime occurs when it is heated, the original substance, melting at 46°·5, being gradually converted into a new modification, which melts at 12°. It is noteworthy that the acetaldoxime melting at 12° is slowly reconverted into that melting at 46°·5 on standing at ordinary temperatures. The authors term the substance melting at 46°·5 α-acetaldoxime, that melting at 12° being named β-acetaldoxime.—Sulphonic acids derived from anisoils (No. i.), by G. T. Moody. The author finds that contrary to the statement of Kekulé, and of Opl and Lippmann, anisoil and phenetoil afford only parasulphonic acids on sulphonation. Carefully purified anisoil was dissolved in concentrated sulphuric acid, and the product poured into water, when part of the anisoil was liberated, showing that as in the case of phenol an intermediate compound is formed before the sulphonic acid. The anisoil thus set free was treated with strong sulphuric acid at 80°, when complete sulphonation occurred. The solution yields a well-defined calcium salt; no indications of the presence of an isomeride were found. The calcium, potassium, and sodium salts of the anisoil parasulphonic acid obtained in this way are described, together with the sulphochloride and sulphonamide. Pure phenetoil similarly is shown to yield only the parasulphonic acid. The products of sulphonation, either with sulphuric acid or with chlorosulphonic acid, are in both cases the same, only one sulphonic acid resulting.—The formation of trithionate by the action of iodine on a mixture of sulphite and thiosulphate, by W. Spring. In his paper on the investigation of the change proceeding in an acidified solution of sodium thiosulphate, Colefax credits the author with having stated that trithionate of sodium is produced when iodine acts on a mixture of sodium sulphite and thiosulphate, and further denies that this is the case. The author used potassium salts, and not sodium salts, but, owing to an error in the abstract of Spring's original paper, Colefax was led to believe that sodium salts were used. The difference in the behaviour of the potassium and sodium salts is very striking, and arises from the greater instability of the sodium polythionates already pointed out by the author. Another difference between the two sets of experiments is found in the employment by Colefax of a larger proportion of iodine than that used by the author. The equation

$$K_2SO_3 + K_2S_2O_3 + I_2 = K_2S_3O_6 + 2\,KI$$

requires less iodine than would be necessary to oxidize the sulphite to sulphate, and the hyposulphite to tetrathionate of sodium. The author does not, however, contend that the formation of trithionate takes place in accordance with the equation

$$Na_2S_2O_3 + Na_2SO_3 + I_2 = Na_2S_3O_6 + 2NaI.$$

He is convinced that sulphites have the property of desulphurising the tetrathionates, so as to convert them into trithionates. It would hence be more consistent to admit that the sodium sulphite which owes its existence to the employment of a reduced quantity of iodine decomposes the small quantity of sodium tetrathionate produced in the first instance, thus,

$$Na_2S_4O_6 + Na_2SO_3 = Na_2S_3O_6 + Na_2S_2O_3.$$

The statement erroneously ascribed by Colefax to the author seems, in consequence, to be really correct. It is, however, indispensable that the experiments should be performed under exactly the same conditions as those employed in the work on the potassium salts.—The determination of the temperature of steam arising from boiling salt solutions, by J. Sakurai. The evidence now on record as to the temperature of the steam arising from boiling salt solutions is exceedingly unsatisfactory and inconsistent. Such being the case, the author has devised a method for accurately measuring this temperature, and finds that the temperature of the steam escaping from a boiling salt solution is the same as that of the solution. The conditions for success are:—(1) The thermometer used must be kept from contact even with the smallest drops of the solution thrown up by ebullition. (2) The effect of cooling of the thermometer by radiation must be rendered insignificant in proportion to the heating up by the steam. This condition is readily fulfilled by the expedient of combining the introduction of steam from without with the ebullition by the lamp. (3) The walls of the chamber surrounding the thermometer must be sufficiently protected from external cooling, and yet, at the same time, must not be heated to the temperature of the steam. This is effected by jacketing the steam chamber with the vapour evolved from dilute acetic acid boiling at about 2° lower than the salt solution. The agreement between the numbers representing the temperature of the steam and that of the boiling salt solution is good.—Note on an observation by Gerlach of the boiling-point of a solution of Glauber's salt, by J. Sakurai. Some years ago Gerlach stated that the steam escaping from a boiling solution of Glauber's salt containing a crystalline magma of the anhydrous salt indicates a temperature of 100°, whilst the liquid is boiling at 82° or even 72°. The author finds that this is hardly true, for it is only a wet mass of sodium sulphate crystals that is heated. The steam, consequently, does not arise uniformly from the heated mass, but escapes from channels produced in those portions of it which are in contact with the sides of the vessel. The central portion of the magma therefore may be at a low temperature, whilst steam at 100° is issuing from the sides.—Chemistry of the thioureas, Part ii., by E. A. Werner. It is pointed out that the paper recently published by Bertram on the monophenylthioureas was evidently written in ignorance of the fact that the bulk of the work detailed therein has been already published by the author. A number of new derivatives of thiourea are now described.

Geological Society, May 11.—W. H. Hudleston, F.R.S., President, in the chair.—The President announced that a bust of the late Sir Charles Lyell had been kindly presented to the Society by Mrs. Katherine Lyell, through the intermediary of Prof. J. W. Judd, F.R.S.—The following communications were read:—On the so-called gneiss of Carboniferous age at Guttannen (Canton Berne, Switzerland), by Prof. T. G. Bonney, F.R.S. It is stated by Dr. Heim (*Quarterly Journal*, vol. xlvi. p. 237) that the stems of *Calamites* have been found at Guttannen in a variety of gneiss, *i.e.* in one of a group of rocks which exactly "resemble true crystalline schists in mode of occurrence. Petrographically they are related to them by passage rocks; at least the line of separation is not easily distinguished. . . . The Palæozoic formations mostly show an intimate tectonic relation to the crystalline schists, and have been converted petrographically into crystalline schists." The Author describes the result of a visit to the section at Guttannen in company with Mr. J. Eccles (to whom he is greatly indebted for kind assistance), and of his subsequent study of the specimens then collected. The belt of sericitic "phyllites and gneisses," presumably of Carboniferous age, represented on the Swiss geological map (Blatt xiii.) as infolded, at and above Guttannen, in true crystalline gneissoid rocks, is found on examination to consist partly of true gneisses, partly of detrital rocks. The boulder from which the stems in the Berne Museum were obtained belongs to the latter. These rocks sometimes present macroscopically, and occasionally even microscopically, considerable resemblance to true gneisses, but this proves on careful examination to be illusory. They are, like the Torridon Sandstone of Scotland, or the *Grès feldspathique* of Normandy, composed of the detritus of granitoid or gneissoid rock, which sometimes forms a mosaic resembling the original rock, and which has been generally more or less affected by subsequent pressure and the usual secondary mineral changes. Thus, if the term be employed in the ordinary sense, they are no more gneisses than the rocks of Carboniferous age at Vernayaz (Canton Valais) are mica-schists, but in some cases the imitation is unusually good, and, so far as the author saw, there are at Guttannen neither conglomerates nor slates to betray the imposition, as happens at the other locality. The reading of this paper was followed by a discussion, in which the President, Prof. Judd, Mr. Eccles, General McMahon, Mr. Rutley, Prof. Blake, Prof. Bonney, and Prof. Seeley took part.—On the lithophyses in the obsidian of the Rocche Rosse, Lipari, by Prof. Grenville A. J. Cole, and Gerard W. Butler. The rock described in this paper differs in no essential particular from that at Forgia Vecchia, or from the obsidian on the north flank of Vulcano; but the specimens show in a specially striking manner the passage through various stages of lithophysal structure, from indisputable steam-vesicles with glassy walls to typical solid spherulites. A full description is given of the formation of spherulites by a double process—firstly, divergent growth from the margins of vesicles outwards, and secondly, convergent growth inwards from the margins towards the centres of the hollows, until in the smallest cases the fibres from the opposite sides of the vesicle may meet in the centre, producing a spherulite, which, but for the occurrence of intermediate stages, might be supposed to have originated entirely by divergent growth. The authors give details of the appearances presented by intermediate stages of growth. The prevailing type of spherulite, both in Lipari and Vulcano, shows in section a dusky fibrous central area, which may possess concentric as well as radial structure, surrounded by an irregular brown cloudy zone of various width. The authors' studies lead them to the conclusion that this type owes its characters to the dual mode of growth, and therefore to the original presence of vesicles in the rock. Commonly the process of infilling does not go so far as this; on the ends of the felspar fibres plates of tridymite are deposited, and this seems to close the growth. It is clear that the lithophysal structure of the Lipari obsidians was formed during the cooling of the mass, and not by subsequent amygdaloidal infilling of vesicles. The authors discuss the effect of confined vapours on such rocks as those forming the subject of the paper, noting that these vapours may be kept at a high temperature for a considerable time, each vesicle thus becoming a sphere of hydrothermal action; so that if the surrounding glass remains at a temperature little below its fusion-point, crystallization will be promoted in it, and at the same time the action of the vapour in the vesicle will produce reactions on its walls. An appendix, by Prof. Cole, treats of the lithophyses and hollow spherulites of altered rocks. While admitting the presence of true lithophyses in many of the Welsh lavas, he is not prepared to abandon a former suggestion that the interspaces between successive coats of the Conway lithophyses result from alteration of a formerly solid mass. In the lavas of Esgair-felen and near the Wrekin he has no doubt as to the production of "hollow spherulites" by ordinary processes of decay. The typical Continental pyromerides are truly spherulitic, as is much of the Wrekin lava. In the latter case and that of the rocks of Bouley Bay it will be difficult to distinguish between infilled primary and secondary cavities. In the discussion which followed the reading of this paper Prof. Bonney, Prof. Judd, General McMahon, Mr. J. W. Gregory, Mr. Rutley, Prof. Cole, and Mr. G. W. Butler took part.

Royal Meteorological Society, May 18.—Dr. C. Theodore Williams, President, in the chair.—The following papers were read:—Raindrops, by Mr. E. J. Lowe, F.R.S. The author has made over 300 sketches of raindrops, and has gathered some interesting facts respecting their variation in size, form, and distribution. Sheets of slate in a book form, which could be instantly closed, were employed; these were ruled in inch squares, and after exposure the drops were copied on sheets of paper ruled like the slates. Some drops produce a wet circular spot, whilst others, falling with greater force, have splashes around the drops. The same sized drop varies considerably in the amount of water it contains. The size of the drop ranges from an almost invisible point to that of at least 2 inches in diameter. Occasionally large drops fall that must be more or less hollow, as they fail to wet the whole surface inclosed within the drop. Besides the ordinary raindrops, the author exhibited diagrams, showing the drops produced by a mist floating along the ground, and also the manner in which snow-flakes, on melting, wet the slates.—Results of a comparison of Richard's anémo-cinémographe with the standard Beckley anemograph at the Kew Observatory, by Mr. G. M. Whipple. This instrument is a windmill vane anemometer, and is formed by six small wings or vanes of aluminium, 4 inches in diameter, inclined at 45°, rivetted on very light steel arms, the diameter of which is so calculated that the vane should make exactly one turn for a metre of wind. Its running is always verified by means of a whirling frame fitted up in an experimental room, where the air is absolutely calm, and, if necessary, a table of corrections is supplied. The recording part of the apparatus differs entirely from any other anemometer, and is called the anémo-cinémographe, and in principle is as follows:—The pen, recording on a movable paper, is wound up at a constant rate by means of a conical pendulum acting as a train of wheel links, whilst a second train, driven by the fan, is always tending to force it down to the lower edge of the paper; its position, therefore, is governed by the relative difference in the velocity of the two trains of wheel-work, being at zero when the air is calm, but at other times it records the rate of the fan in metres per second. The author has made a comparison of this instrument with the standard anemometer at the Kew Observatory, and finds that it gives exceedingly good results.—Levels of the River Vaal at Kimberley, South Africa, with remarks on the rainfall of the watershed, by Mr. W. B. Tripp. Measurements of the height of the River Vaal have for several years past been made at the Kimberley Waterworks. These gaugings having been placed at the disposal of the Society, the author has compared them with the rainfall of the watershed. There is a marked period of floods and fluctuations at a comparatively high level from about the end of October to the latter part of April, and a period of quiescence during which the river steadily falls, with very slight fluctuations from about April 19 to October 31. The highest flood (52·5 feet) occurred in 1880, the next highest being 50·3 feet on January 24, 1891.

OXFORD.

University Junior Scientific Club, May 4.—The meeting was held in the University Museum. In private, business regulations about the "Robert Boyle Lecture" were passed by the Club.—Papers were read on the action of light on metallic iodides, by Mr. Douglas Berridge; on the colours of birds, by Mr. F. Finn; and on Caliche, by Mr. P. Elford.

May 13.—At an open meeting Mr. E. F. im Thurn (Exeter) delivered a lecture on "Primitive Games of the Red Men of Guiana." Prof. Tylor afterwards addressed the Club.—The inaugural "Robert Boyle Lecture" will be given at a *conversazione* on May 27. All old members of the Club are cordially invited.

PARIS.

Academy of Sciences, May 16.—M. d'Abbadie in the chair.—Contribution to the history of silico-carbon compounds, by M. P. Schutzenberger. The compound, SiC, has been produced by long heating of silicium diluted with silica in carbon crucibles. The friable mass is broken up, heated with potash solution, which dissolves out the silicium, and some silica, and then boiled with moderately concentrated hydrofluoric acid, by which all the silica is taken up and silicium nitride is converted into silicium fluoride and ammonium fluoride. The clear green pulverulent residue of SiC is not attacked by potash or by boiling HF; it is infusible, and at a white heat forms SiCO.—On the determination of the density of liquefied gases and their saturated vapours; elements of the critical point of carbonic acid, by M. E. H. Amagat. The critical constants for carbonic acid are given as—temp. = 31°·35 C., pressure = 72·9 atmos., density = 0·464.—Observation of the partial eclipse of the moon on May 11–12, 1892, by MM. Codde, Guérin, Nègre, Zielke, Valette, and Léotard.—On the theory of *fonctions fuchsiennes*, by M. L. Schlesinger.—On the relations existing between the infinitesimal elements of two reciprocal polar surfaces, by M. Alphonse Demoulin.—On transformations in mechanics, by M. Paul Painlevé.—The physiological scale of distinct vision, applications to photometry and *photo-esthésiométrie*, by M. W. Nicati.—On a method of separation of xylenes, by M. J. M. Crafts.—Calculation of boiling-points of compounds with simple terminal substitution, by M. G. Hinrichs.—Method for the proximate analysis of chlorophyll extracts; nature of chlorophyllane, by M. A. Étard.—Influence of the nature of the soil on vegetation, by M. J. Raulin.—Presence of fumarine in one of the Papaveraceæ, by M. J. A. Battandier.—On some muscular anomalies in man, by M. Fernand Delisle.—On the apparently teratological origin of two species of *Triclades*, by M. P. Hallez.—On the theory of gills and the parablast, by M. F. Houssay.—The origins of the wing nerve among the Coleoptera, by M. Alfred Binet.—The nervous system of *Nerita polita*, by M. L. Boutan.—On the origin and formation of the chitinous coat of the larvæ of *Libellules*, by M. Joannes Chatin.—On the microscopic structure of ooliths from the *bathonien* and *bajocien* of Lorraine, by M. Bleicher.—The odoriferous properties of alcohols of the fatty series, by M. Jacques Passy. The odoriferous power, as measured by the inverse of the millionths of a gram present in one litre of air when the odour can be just distinguished, increases regularly with the molecular weight.—On the lack of movement of the deep oceanic waters, by M. J. Thoulet.

BERLIN.

Physiological Society, April 27.—Prof. du Bois-Reymond, President, in the chair.—Dr. Boruttau gave an account of experiments made to determine the cause of the difference in latent period observed during the direct and indirect stimulation of muscles, being, as is well-known, greater (with maximal and supra-maximal stimuli) in the latter mode of stimulation. According to some observers the difference is due to the resistance offered by the end-plates, whereas some regard it as due rather to a summation of stimuli during direct stimulation. The speaker had satisfied himself by a careful repetition of the experiments under many varying conditions that the difference is due solely to the resistance of the end-plates. In connection with the above, Prof. Gad pointed out the possible important bearing of the results obtained on the processes which go on in other organs. Thus recent anatomical research has shown that in the central nervous system there is no complete continuity between the axis-cylinders and ganglia, hence the existence of some intermediate structure must be assumed, and a portion at least of the slowing which impulses experience in the central nervous system may be due to the resistance offered by this structure.—Prof. Wolff exhibited a patient in whom the larynx had been completely extirpated some seven months previously, and who was now able, by means of an artificial larynx, to speak quite loud and clearly. Prof. Gad gave an historical account of the construction of artificial larynxes, of the requirements which these instruments must satisfy, and of recent improvements in the cannulæ employed by patients.

Physical Society, May 6.—Prof. Kundt, President, in the chair.—Dr. Gross spoke on the principle of entropy, and criticised several formulæ of Clausius and Zeuner.

[In the reports of the Berlin Scientific Societies, NATURE, vol. xlv. p. 599, *for* Schumbert *read* Schubert, and *for* Lammer and Brodhan *read* Lummer and Brodhun.]

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Genesis I. and Modern Science: Dr. C. B. Warring (New York, Hunt and Eaton).—Analyse des Vins: Dr. L. Magnier de la Source (Paris, Gauthier-Villars).—Tiroirs et Distributeurs de Vapeur: A. Madamet (Gauthier-Villars).—Studies in South American Native Languages: Dr. D. G. Brinton (Philadelphia).—Die Eibe in Westpreussen: H. Conwentz (Danzig, Bertling).—Wood-Notes Wild Notations of Bird Music: S. P. Cheney (Boston, Lee and Shepard).—Lehrbuch der Botanik, Erster Band: Dr. A. B. Frank (Leipzig, Engelmann).—The Theory of Substitutions and its Applications to Algebra: Dr. F. Netto, translated by Dr. F. N. Cole (Ann Arbor, Michigan, *Register* Publishing Company).—Results of the Meteorological Observations made at the Government Observatory, Madras, during the Years 1851–90, edited by C. M. Smith (Madras).—Watts's Dictionary of Chemistry, vol. iii., revised, &c., by H. F. Morley and M. M. P. Muir (Longmans).—Practical Enlarging: J. A. Hodges (Iliffe).—The First Principles of Photography: C. I. Leaper (Iliffe).—Smithsonian Report, U.S. National Museum, 1889 (Washington).—Key to J. B. Lock's Elementary Dynamics: G. H. Lock (Macmillan).—The Anatomy, &c., of the Blow-Fly, Part 3: B. T. Lowne (Porter).

PAMPHLETS.—On the Organization of Science: A Free Lance (Williams and Norgate).—The Nitrate Fields of Chile: C. M. Aikman.—Sadducee *versus* Pharisee: G. M. McCrie (Bickers).

SERIALS.—Quarterly Journal of the Geological Society, vol. xlviii. Part 2, No. 190 (Longmans).—Engineering Magazine, May (New York).—Himmel und Erde, May (Berlin, Paetel).—Transactions of the Royal Irish Academy, vol. xxix. Part 19 (Williams and Norgate).—Verhandlungen des Naturhistorischen Vereines der Preussischen Rheinlande, &c.—Achtundvierzigster Jahrgang Fünfte Folge, 8 Jahrg., Zweite Hälfte (Bonn, Cohen).—Bulletins de la Société d'Anthropologie de Paris, tome 2 (1891), 3e. Fasc. (Paris, Masson).—Journal of the Chemical Society, May (Gurney and Jackson).—Institute of Jamaica, Bulletin No. 1, A Provisional List of the Fishes of Jamaica: T. D. A. Cockerell (Kingston).—Rapport Annuel sur l'État de l'Observatoire de Paris, 1891, le Contre-Amiral Mouchez (Paris, Gauthier-Villars).—Indian Museum Notes, vol. ii. No. 5 (Calcutta).—Journal of the Institution of Electrical Engineers, No. 98, vol. xxi. (Spon).—Mémoires de la Société de Physique et d'Histoire Naturelle de Genève, Vol. Supplémentaire, Centenaire de la Fondation de la Société (Genève).

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THURSDAY, JUNE 2, 1892.

THE GRAMMAR OF SCIENCE.

The Grammar of Science. By Karl Pearson, M.A., Sir Thomas Gresham's Professor of Geometry. "The Contemporary Science Series." (London: Walter Scott, 1892.)

ONE chief merit of this book is its exposition of the meaning of scientific law. There still exists, unfortunately, a type of mind which delights in such phrases as "the reign of law," the "immutable laws of Nature," and so on. The truly scientific mind has, however, been long familiar with the truth that a so-called law of Nature is simply a convenient formula for the co-ordination of a certain range of phenomena. It is this which Prof. Pearson so emphatically, if somewhat redundantly, expounds in the earlier chapters of the "Grammar." As he delights in putting it, a scientific law is a description in mental shorthand of certain sequences of sense-impressions. Through these sense-impressions alone can we gain any knowledge of what we are accustomed to call the external world. Thus the Universe as pictured by the scientific mind is a purely mental product. We can assert, scientifically, nothing regarding its constitution other than what we may validly infer from our perceptions and the conceptions based on these; and even then we must never forget that the reality to us is conditioned wholly by our powers of perception. This is the grand argument of the grammarian of science.

In developing his theme he introduces not a few interesting questions and analogies. Take, for example, his comparison of the brain to a telephone exchange. Here Reason, presiding as clerk, finds by experience that a certain subscriber always desires to correspond with a certain other subscriber. As soon as the call-bell from the former sounds, the clerk mechanically links him to the latter. "This corresponds to an habitual exertion following unconsciously on a sense-impression." Other analogies are obvious. Now, just as the clerk would obtain a very scrappy knowledge of the outside world if he had to trust simply to the messages which stream past him through the exchange, so (it is suggested) the picture our mind forms of the external world acting upon us through our sense-impressions may be very wide of the reality. Of course analogies must not be pressed too far. Yet it does seem that this analogy of the telephone exchange could be worked out most consistently by the despised teleologist. To Sir Thomas Gresham's Professor of Geometry, however, a telephone exchange evolving its own clerk is as simple a matter as an uninterrupted stream of sense-impressions creating Spencerianly a consciousness.

But Prof. Pearson is no mere preacher of familiar doctrines. He is a second Hercules, self-appointed to clear the scientific stables of all materialistic and metaphysical rubbish. He labours at the task of proving how illogical is the mind that passes to "the beyond" of the sense-impressions and the conceptions directly based on these. Thus he argues that, because the Universe is known only as our own mental product, we have no right to infer a mind in or above Nature as an explanation of the universality of the scientific law. Nevertheless, it behoves him to find a rational substitute for the law of continuity on which the authors of the Unseen Universe build their edifice. Consequently on p. 121 we read:—

> "It is therefore not surprising that normal human beings perceive the same world of phenomena, and reflect upon it in much the same manner."

Why not surprising? Because, as we learn from the preceding sentence, human beings "in the normal civilized condition have perceptions and reflective faculties nearly akin." But why nearly akin? Well, it has to be so because "the world of phenomena must be practically the same for all normal human beings," or the universality of scientific law will fail. Putting in the definitions of the terms in the first quoted sentence we read:—It is therefore not surprising that beings, who have perceptive and reflective faculties capable only of producing practically the same world of phenomena, perceive the same world of phenomena and reflect upon it in much the same manner. In this exquisite cycle of reasoning what, we ask, is the logical work done?

Our grammarian poses as a logician of the straitest sect. Bad logic he cannot abide; and since apparently he cannot read a book without seeing the cloven hoof he must have rather a sorry time of it. His own logic must, of course, be flawless. So, when we are told with reiterated emphasis that time and space are but modes of perception, and are then asked to imagine our Universe in time and space without a consciousness to perceive it, we feel a sinking at the heart. Things, we find, can exist under certain modes of a non-existent perception. The laws of Nature are a mental product; yet a certain evolution theory logically based upon them quite eliminates the mental. We are reminded of the sagacious carpenter who sat high and lifted up on the end of the bracket beam he was sawing through; or of the small boy who spent his wealth in buying a purse to hold it in.

A large section of Prof. Pearson's book is destructive criticism. "Cause," "Force," and "Matter" are as red rags to him. Cursed be he who uses these words without clearly defining, in footnote or otherwise, their significance according to the definitions given in the "Grammar of Science." Sir Isaac Newton is severely visited for his sins; Thomson and Tait get a thorough drubbing; Maxwell is censured for his bad logic; and Prof. Tait especially, if we are to judge of him through the medium of this book, must have done more to retard the progress of science than any other single man of the century. Sound criticism is always welcome; but "smart" controversy of the hustings type is rarely sound in print. As a fair example of our grammarian's method, take his critique of Maxwell's descriptions (not definitions be it noted) of the intimate relation between matter and energy. Maxwell says, "We are acquainted with matter only as that which may have energy communicated to it from other matter, &c.," and "Energy, on the other hand, we know only as that which . . . is continually passing from one portion of matter to another." These are represented as meaning that "the only way in which we can understand matter is through the energy which it transfers," and "the only way to understand energy is through matter. Matter has been defined in terms of energy, and energy again in terms of matter." By what logic or grammar can *understand* be substituted for *are acquainted with* or *know;* and by what right is a description twisted into a definition? Words in their usual meanings may, however, be of little consequence to a writer who persists in using the English word *resume* in the French sense. It seems to us that Prof. Pearson has altogether missed the significance of the word "objective" as used by Prof. Tait, to whom, as everyone knows or should know, we owe the first clear presentation of the dogma that force has no objective existence. At any rate, we are surprised to find in the "Grammar of Science" no distinct reference to the two grand principles of all science—to wit, the conservation of matter and the conservation of energy. This omission by an avowed writer on the principles of science is certainly matter of surprise. As regards the views of force expounded in the book, the author is simply a disciple of Prof. Tait. If not, he must regard Tait as "that worst of plagiarists"—the man who made the discovery before he did. Prof. Pearson has, indeed, a certain fatality for having dealings with that most unsatisfactory kind of plagiarism. In Tait's "Properties of Matter," first edition (1885), paragraph 162, are written these words :—

> "Sir W. Thomson has shown that if space be filled with an incompressible fluid, which comes into existence in fresh quantities at the surface of every particle of matter, at a rate proportional to its mass, and is swallowed up at an infinite distance, or, if each particle of matter constantly swallows up an amount proportional to its mass, a constant supply being kept up from an infinite distance,—in either case gravitation would be accounted for."

If this is not *essentially* the theory of "ether-squirts" which "the author has ventured to put forward," what then is the ether-squirt? The quotation just given occurs in Tait's seventh chapter, which, being empty of "red rags," probably failed to come within Prof. Pearson's sphere of perception.

Be it noted that we do not criticize our author's views as to the significance of such words as force and cause; but we cannot say we fancy his critical tone towards others. He himself uses the phrase "acceleration of A due to B," but warns the reader in a footnote against taking the phrase in its literal sense; yet anybody else from Newton down the centuries who has dared to use similar phrases is sneered at as a searcher after the unknowable "why."

For example, in his criticism of Newton's first law of motion, what right has he to say that Newton "was thinking of force in the sense of mediæval metaphysics as a cause of change in motion"? What is the perceptual or conceptual basis of this assumed certitude? Newton was probably thinking of *vis impressa*, the very grammatical form of which shows that there was nothing ultimate implied in the *vis*. After discussing the various kinds of *vires* that have to be dealt with, and pointing out clearly by definitions and descriptions their precise meanings, Newton concludes one paragraph in these words :—

> "*Mathematicus duntaxat est hic conceptus: Nam virium causas et sedes physicas jam non expendo.*"

Then a little further on we read :—

> "*Has vires non physice sed mathematice tantum considerando. Unde caveat lector, ne per hujusmodi voces cogitet me speciem vel modum actionis causamve aut rationem physicam alicubi definire vel centris* (*quæ sunt puncta mathematica*) *vires vere et physice tribuere; si forte aut centra trahere, aut vires centrorum esse dixero.*"

Can it be that Prof. Pearson has never read Newton's "Principia," and has he forgotten that the complete title is "Philosophiæ Naturalis Principia Mathematica"? To insinuate that Newton's laws of motion (which, it should never be forgot, are intimately associated with the *Definitiones*) are incomplete because they may not possibly apply to corpuscles other than those of "gross" matter, to corpuscles of all imaginable types in short, implies a complete misapprehension of the whole purpose and scope of the "Principia." Again, our grammarian pounces upon the word "body," or *corpus*, as used by Newton, who should at least have used particle or corpuscle. In Definition I. will be found the meaning intended by Newton to be attached to the word *corpus;* but in any case the whole phraseology of the first law is quite intelligible to the candid mind. Newton had a fine faith in his reader. He gave the *Definitiones* and *Axiomata* in a form that appealed at once to the common experiences of thoughtful minds; and what more do we need?

Prof. Pearson characterizes the second law as a "veritable metaphysical somersault. How the imperceptible cause of change in motion can be applied in a straight line surpasses comprehension, &c." This may be smart, but is it relevant? Where does Newton define *Vis Motrix* as the "imperceptible cause of change in motion"?

We have not space to enter upon a discussion of the five laws of motion suggested by Sir Thomas Gresham's Professor of Geometry as a true non-metaphysical basis for all science. They are good enough in their way; but they seem to lack that direct reference to ordinary facts of experience which is a desideratum of all physical axioms. They begin with a dance of molecules and end with a measure of force Their ostensible merits are their logical form and their comprehensiveness—ether corpuscles as well as matter corpuscles being nominally included. Yet we have to confess our inability to see that these laws of motion can effect more than Newton's. Dynamics, in all its branches, still is Newtonian.

In its discussion of the meaning of scientific law, in its presentation of kinematic principles, and in its treatment of certain present-day speculations as to the constitution of matter and of ether, Prof. Pearson's book is at once interesting and instructive. There is much in it fitted to arrest the materialistic tendency of many who are devotees of science to the exclusion of all other intellectual activities. Yet its own conclusions are as materialistic as they well can be. The automaton theory of the human will, and the spontaneous generation of life, are articles of its creed. In the second last chapter we are treated to a choice collection of charming dogmatisms. Perhaps the most charming of all is the author's "unwavering belief" that the hitherto undiscovered formulæ which are to make history a science "can hardly be other than those which so effectually describe the relations of organic to organic and of organic to inorganic phenomena in the earlier phases of their development." A curious assertion, surely, for one to make who objects to Newton's laws of motion because they don't include imaginable but still unknown types of corpuscular motion. The particular value, however, of this confession of faith is that it enables the confessor to convict of scientific heresy Prof. Robertson Smith and all others who cannot regard it as other than an assumption. To believe as Prof. Pearson believes is to believe scientifically; all other belief is rotten. As the "auld licht" dame said when telling over the number of the elect, "Ay, there's jist me and John; and whiles I'm no that sure o' John." C. G. K.

THE TEACHING OF THE PRINCIPLES OF CHEMISTRY.

Laboratory Practice: A Series of Experiments on the Fundamental Principles of Chemistry. A Companion Volume to "The New Chemistry." By Josiah Parsons Cooke, LL.D., Erving Professor, and Director of the Chemical Laboratory, Harvard University. Pp. 192. (London: Kegan Paul, Trench, Trübner, and Co., 1892.)

THIS little book represents another attempt to teach the theory of chemistry upon the basis of a narrowly restricted experience of facts and phenomena. Whether this is possible is a question debatable, and still, in fact, debated among teachers. That it is possible to make the study of chemistry by young people, as a form of intellectual exercise, more useful than has usually been the case there can be no doubt, and that much instruction could be got out of a course such as this which is indicated in Prof. Cooke's little work is certain. The book appears to be intended as a guide for the teacher as much as for the pupil, and much would depend upon the qualifications of the former for the work of demonstration and exposition. It contains directions for the performance of a system of experiments; and to do justice to the system the teacher ought carefully to study the instructions given in the introduction, and to act upon them. And to those who know anything of the manner in which chemistry is too often taught in the schools of this country, either by the visiting "science teacher," who knows little, or by the mathematical master, who usually knows nothing at all about the subject, such remarks as the following, taken from the introduction, will seem particularly welcome and appropriate.

The author says:

> "Experiments are only of value as parts of a course of instruction logically followed out from beginning to end. In such a course there must be necessarily a great deal to be filled out by the teacher, and this can vastly better be taught from his lips, with such illustrations as he can command, than from any books."

And again,

> "The best apparatus will be of no use unless the teacher stands before it and speaks to his pupils out of the fulness of his own knowledge. This is an essential condition of success, and without it the experimental method should never be attempted."

But after these things have all been duly noted and acted upon, a glance at the table of contents is apt to raise a doubt whether after all the erection of so large a superstructure is justifiable or practicable upon foundations so slender. The book begins at p. 13, and thence to p. 52, with the exception of three or four pages about water, the whole is devoted to the physical properties of liquids and solids represented by water and air. Then we come to oxygen, hydrogen, sulphur and its oxides, chlorine, carbon and the oxides of carbon, ethylene, nitrogen, nitric acid, ammonia, magnesium, zinc, sodium, copper, and iron, all of which are included in the fifty pages following. Then comes a chapter on general principles, a third on molecules and atoms, followed by chapters on symbols and nomenclature, molecular structure, and thermal relations.

This is not the first book which has appeared with similar objects. In this country there have been Prof. Ramsay's little book on "Chemical Theory," Muir and Carnegie's "Practical Chemistry," Shenstone's "Practical Introduction to Chemistry," and probably others, which seem to aim at dealing with chemistry in the same kind of way, which is intended to be a way of pleasantness and a short cut to rather exalted territory. The road, however, is bordered by precipices unseen by the young traveller.

The advocates of this kind of system, which consists in passing from one or two rough experiments, or observations, direct to great generalizations, anticipate great things from its general adoption. All the rising generation who come under its influence are to possess greatly developed powers of observation and reasoning. Some of those who have been accustomed to old-fashioned ways of getting a good grip of facts, and some stock of experience before proceeding to difficult investigation, are not convinced, and are inclined to doubt whether school boys and girls can be made to reason out for themselves problems which have cost for their elucidation the work of generations of men. And the logic of the process is often more than questionable. Here is an example (p. 110). The law of the conservation of mass is supposed to be established by a single experiment, which consists in burning a bit of phosphorus in a jar, and showing that there is no loss of weight.

> "Hence it must be that, *The sum of the weights of the products of a chemical change is exactly equal to the sum of the weights of the factors.* We may conceive of any chemical process as taking place in an hermetically sealed space—indeed the earth is essentially such a space—and hence this law must be universally true."

Here the process of induction is reduced to collecting a single instance, which is itself imperfect. Surely this is not to stand as an example of the methods of physical science.

One would not wish to be hard upon Prof. Cooke's little book, but with many meritorious features it does not seem to represent a great improvement upon the books referred to above. The naïve statement at the end of the introduction, that the directions can in many cases be improved, cannot be held to excuse the rough and slipshod character of some of the forms of experiment recommended. The book will supply suggestions which will be found useful by some teachers, but the reference to apparatus unfamiliar on this side the Atlantic may be a slight bar to its adoption here. W. A. T.

OUR BOOK SHELF.

Elementary Geography of the British Colonies. By George M. Dawson, LL.D., F.R.S., and Alexander Sutherland, M.A. With Illustrations. (London: Macmillan and Co., 1892.)

THIS volume forms one of the well-known geographical series edited by Sir Archibald Geikie. The part of it for which Dr. Dawson is responsible is that which deals with the British possessions in North America, the West Indies, and the southern part of the South Atlantic Ocean. Mr. Sutherland describes the British colonies, dependencies, and protectorates in the northern part of the South Atlantic, Mediterranean Sea, Africa, Asia (exclusive of India and Ceylon, which are described in a separate volume of the series, by Mr. H. F. Blanford), Australasia, and Oceania. Both writers have enlightened ideas as to the needs of those for whom such books are prepared. They have carefully avoided the bringing together of masses of uninteresting detail, their chief object being to convey a good general idea of the physical features and resources of the British colonies, and of the various ways in which these have affected the distribution of the population and the growth of industry and commerce. The facts are presented simply and clearly, and every page contains statements which an intelligent teacher would have no difficulty in using as texts for pleasant and profitable instruction. Most of the illustrations are from photographs, but there are also several very effective engravings from original drawings by Mr. Pritchett.

Farmyard Manure. By C. M. Aikman, M.A., B.Sc. (Edinburgh and London: Blackwood, 1892.)

WE are told in the preface that this little work is in substance a chapter from a larger work on "Soils and Manures," on which the author is at present engaged. Perhaps we may be excused if we fail to see the necessity of publishing this chapter separately in advance. It certainly contains much information from German works, such as Heiden's "Düngerlehre," but the book is written mainly from the chemist's point of view and not from the farmer's. The pamphlet gives one the impression of having been hurriedly prepared, but no doubt its deficiencies will be remedied in the larger book.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Peripatus from St. Vincent.

SOME of the readers of NATURE will doubtless be interested to learn that, while collecting in St. Vincent on behalf of the Committee appointed for the investigation of the fauna and flora of the Lesser Antilles, Mr. H. H. Smith obtained five examples of the genus *Peripatus*.

The importance of the discovery, or rather rediscovery, of this Arthropod in St. Vincent rests upon the fact that the Rev. L. Guilding procured the first recorded examples of the genus in this same island. A description of these, under the name *juliformis*, was published by this naturalist in 1826, in vol. ii. of the *Zoological Journal.* But from that time until now, a period of 66 years, no additional specimens have been brought to light in this locality; and since Guilding's types have been lost sight of, and his description of them is wanting in detail, the identity of *juliformis* has been involved in considerable obscurity. There can, however, be little if any doubt that the examples collected by Mr. H. H. Smith are specifically identical with those that Guilding described. Nevertheless this assumption receives more support from identity of locality than from the agreement that obtains between the description of *juliformis* and the specimens before me. The largest of these measures 43 mm. in length and 6·5 in width; the smallest, on the contrary, is only 13 mm. long. One example has 34 pairs of legs, two of them 33, one 30, and one 29. The colour of the lower surface may be described as fawn; that of the dorsal side varies from fawn to blackish grey.

Those who are familiar with Mr. Smith's qualifications as a collector need hardly be told that the specimens are on the whole in a satisfactory state of preservation. I consequently hope to be able to prepare a detailed description of the species, to be incorporated in the report upon the Myriopoda of the Lesser Antilles, the identification of the species of this group, together with that of the Scorpions, Pedipalpi, and fresh-water Decapoda, having been kindly intrusted to my care by the members of the Exploration Committee. R. I. POCOCK.

Natural History Museum, May 27.

The Line Spectra of the Elements.

I QUITE agree with Prof. Stoney that Fourier's theorem can be applied to motions which approximate to non-periodic motions in any assigned degree, and for any assigned time. And so the co-ordinates of any arbitrary motion may approximately in any assigned degree and for any assigned time be represented by formulas of this kind:—

$$a_0+a_1\sin\left(\frac{m_1t}{j}+\alpha_1\right)+a_2\sin\left(\frac{m_2t}{j}+\alpha_2\right)+\ldots+a_n\sin\left(\frac{m_nt}{j}+\alpha_n\right),$$

where $m_1, m_2, \ldots m_n$ are positive integers, and j must be chosen sufficiently large to suit the length of the assigned time. This is not the point in Prof. Stoney's reasoning to which I object.

What I want to say is this: If the motion is not periodical, the periods of the circular functions, as well as the amplitudes and phases, are not necessarily definite. That is to say, if we choose a larger value of j, to get a closer approximation for a longer time, the values of $a, \frac{m}{j}, \alpha$ do not necessarily approach definite values, but may become totally different.

Take, for instance, the equation—

$$t = 2j\left[\sin\frac{t}{j} - \tfrac{1}{2}\sin\frac{2t}{j} + \tfrac{1}{3}\sin\frac{3t}{j} - \ . \ . \ . \ \right],$$

which holds good for all values of t between $-j$ and $+j$. Prof. Stoney may say that Fourier's theorem can be applied to the function t. So it can, certainly, if an interval is assigned. But the amplitudes and periods of the single terms are not independent of the length of the interval, and do not approach definite values when the interval increases indefinitely.

The time during which the approximation is to hold good need not be indefinitely long. But the time must be long in comparison with the longest of the periods. Motions of the ether that are represented by such functions will be resolved by a diffraction grating into different rays, but others will not. Prof. Stoney has not noticed that a distinct property of the function is wanted in order to get a proper resolution into a sum of circular functions. His reasonings in chapter iv. of his memoir on the cause of double lines, &c. (Transactions of the Royal Dublin Society, 1891), refer to all functions with or without this property, and therefore do not seem to me to be correct. But I admit that my expression in the passage quoted by Prof. Stoney might have been clearer. C. RUNGE.

Techn. Hochschule, Hannover, May 19.

Maxwell's Law of Distribution of Energy.

IN the current number of the *Philosophical Magazine*, Lord Kelvin describes a dynamical system in which when in stationary motion Maxwell's law of distribution of energy would fail, assuming that law to consist in the ultimate equality of the energy of different parts of the system. He has thus shown the necessity for more accurate language than is commonly employed in the enunciation of that law, and a consideration of his problem may help to determine the limits to which it is subject.

The following statement, whether co-extensive with Maxwell's law or not, will probably be accepted as true as far as it goes—

If there exist a very great number of material systems, the state of each being defined by certain co-ordinates and momenta, and if at a given instant all combinations of the co-ordinates and momenta are represented among them with frequency proportional to $\epsilon^{-h(\chi+T)}$, then that distribution will be permanent—that is, will not be disturbed by the mutual action of the systems, or by any forces in the field of which they are placed, provided all the forces concerned be conservative.

The further question as to how far the solution thus found for the permanent state is unique, has been treated by Boltzmann. He shows that a certain function, which in stationary motion must be positive and constant, necessarily diminishes with the time, so long as any small deviations exist from the above described state. It is obvious that this proposition of Boltzmann's cannot be applicable to all cases of stationary motion. Periodic motions are exceptions, and so is the system described by Lord Kelvin. The question is what assumptions underlie Boltzmann's demonstration. It will be of great advantage if one speaking with Lord Kelvin's authority will assist in defining the limits to which the proposition is subject.

Maxwell, although he may at times have expressed himself incautiously, was aware that the theory was subject to limitations. The statistical, as distinguished from the historical, method was from his point of view of the essence of the theory. A distinction may be drawn between systems, such as Lord Kelvin's, to which the statistical method is inapplicable, and those in which the stationary motion, when attained, is what is called thermal motion—that is, the relative motions are in all directions indifferently, and of that irregular character in which heat is supposed to consist.

It may be that we shall be driven to the conclusion that Maxwell's law has no application except to this class of systems; that it is, in fact, only the limiting state to which a material system approaches as we increase indefinitely the number of its degrees of freedom.

It does, at all events, appear that in cases where the law fails, its failure is due to the introduction of some restrictions on freedom of motion, especially as regards direction. Maxwell pointed out that dæmons—or, shall we say, beings endowed with free will—might by directing the courses of individual molecules cause a system to violate, not only the law of distribution of energy, but even the second law of thermodynamics. What these beings might be supposed to do, that Lord Kelvin in fact does once for all for his system, by prescribing *a priori* the directions of motion and other conditions of the problem to suit his purpose.

H. W. WATSON.
S. H. BURBURY.

The Former Connection of Southern Continents.

WITH reference to the very interesting question treated in Mr. Mellard Reade's letter of your issue of May 26 (p. 77), as to the former connection of southern continents, it may be worth while calling attention to the fact that a great circle, which I may call the Kaffraria Great Circle, connects that coast line with the Falkland Island and the South Georgia Island. It may be presumed that these two islands are the remaining summits of what was once a chain of mountains in connection with the continent of South America. Some of the points through which or near which this great circle passes are as follow—the above-mentioned islands, Port de Sta. Cruz, Patagonia; it traverses the Pacific, runs parallel to the southern branch of the Aleutian Islands, and cuts Kamtchatka somewhat south of Klienchewskaia Volcano, and traversing Asia emerges by the Island of Cutch, so interesting on account of the earthquakes which occurred there. It is of interest to note that South Georgia Island is antipodal to the northern extremity of Saghalian Island.

J. P. O'REILLY.

Royal College of Science for Ireland,
Stephen's Green, Dublin, May 30.

ON THE RELATIVE DENSITIES OF HYDROGEN AND OXYGEN.[1]

IN a preliminary notice upon this subject (Roy. Soc. Proc., vol. xliii. p. 356, February 1888), I explained the procedure by which I found as the ratio of densities 15·884. The hydrogen was prepared from zinc and sulphuric, or from zinc and hydrochloric, acid, and was liberated upon a platinum plate, the generator being in fact a Smee cell, inclosed in a vessel capable of sustaining a vacuum, and set in action by closing the electric circuit at an external contact. The hydrogen thus prepared was purified by corrosive sublimate and potash, and desiccated by passage through a long tube packed with phosphoric anhydride. The oxygen was from chlorate of potash, or from mixed chlorates of potash and soda.

In a subsequent paper "On the Composition of Water" (Roy. Soc. Proc., vol. xlv. p. 425, February 1889), I attacked the problem by a direct synthesis of water from weighed quantities of the two component gases. The ratio of atomic weights thus obtained was 15·89.

At the time when these researches were commenced, the latest work bearing upon the subject dated from 1845, and the number then accepted was 15·96. There was, however, nothing to show that the true ratio really deviated from the 16 : 1 of Prout's law, and the main object of my work was to ascertain whether or not such deviation existed. About the year 1888, however, a revival of interest in this question manifested itself, especially in the United States, and several results of importance have been published. Thus, Prof. Cooke and Mr. T. W. Richards found a number which, when corrected for an error of weighing that had at first been overlooked, became 15·869.

The substantial agreement of this number with those obtained by myself, seemed at first to settle the question, but almost immediately afterwards there appeared an account of a research by Mr. Keiser, who used a method presenting some excellent features, and whose result was as high as 15·949. The discrepancy has not been fully explained, but subsequent numbers agree more nearly with the lower value. Thus, Noyes obtains 15·896, and Dittmar and Henderson give 15·866.

I had intended further to elaborate and extend my observations on the synthesis of water from weighed quantities of oxygen and hydrogen, but the publication of Prof. E. W. Morley's masterly researches upon the "Volumetric Composition of Water" (*Amer. Journ. Sci.*, March 1891) led me to the conclusion that the best contribution that I could now make to the subject would be by the further determination of the relative densities of the two gases. The combination of this with the number 2·0002,[2] obtained by Morley as the mean of astonishingly concordant individual experiments, would give a better result for the atomic weights than any I could hope to obtain directly.

In the present work two objects have been especially kept in view. The first is simplicity upon the chemical side, and the second the use of materials in such a form that the elimination of impurities goes forward in the normal working of the process. When, as in the former determinations, the hydrogen is made from zinc, any impurity which that material may contain and communicate to the gas cannot be eliminated from the generator; for each experiment brings into play a fresh quantity of zinc, with its accompanying contamination. Moreover, the supply of acid that can be included in one charge of the generator is inadequate, and good results are only obtained as the charge is becoming exhausted. These difficulties are avoided when zinc is discarded. The only material consumed during the experiments is then the water, of which a large quantity can be included from the first. On the other hand, the hydrogen liberated is necessarily contaminated with oxygen, and this must be removed by copper contained in a red-hot tube. In the experiments to be described the generator was charged with potash,[1] and the gases were liberated at platinum electrodes. In the case of a hydrogen filling, the oxygen blew off on one side from a mercury seal, and on the other the hydrogen was conveyed through hot tubes containing copper. The bulk of the aqueous vapour was deposited in a small flask containing strong solution of potash, and the gas then passed over solid potash to a long tube packed with phosphoric anhydride. Of this only a very short length showed signs of being affected at the close of all operations.

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[1] "On the Relative Densities of Hydrogen and Oxygen. II." Abstract of a paper by Lord Rayleigh, Sec.R.S., read at the Royal Society on February 18, 1892.

[2] It should not be overlooked that this number is difficult to reconcile with views generally held as to the applicability of Avogadro's law to very rare gases. From what we know of the behaviour of oxygen and hydrogen gases under compression, it seems improbable that volumes which are as 2·0002 : 1 under atmospheric conditions would remain as 2 : 1 upon indefinite expansion. According to the formula of Van der Waals, a greater change than this in the ratio of volumes is to be expected.

With respect to impurities, other than oxygen and oxides of hydrogen, which may contaminate the gas, we have the following alternative. Either the impurity is evolved much more rapidly than in proportion to the consumption of water in the generator, or it is not. If the rate of evolution of the impurity, reckoned as a fraction of the quantity originally present, is not much more rapid than the correspondingly reckoned consumption of water, the presence of the impurity will be of little importance. If, on the other hand, as is probable, the rate of evolution is much more rapid than the consumption of water, the impurity is soon eliminated from the residue, and the gas subsequently generated becomes practically pure. A similar argument holds good if the source of the impurity be in the copper, or even in the phosphoric anhydride; and it applies with increased force when at the close of one set of operations the generator is replenished by the mere addition of water. It is, however, here assumed that the apparatus itself is perfectly tight.

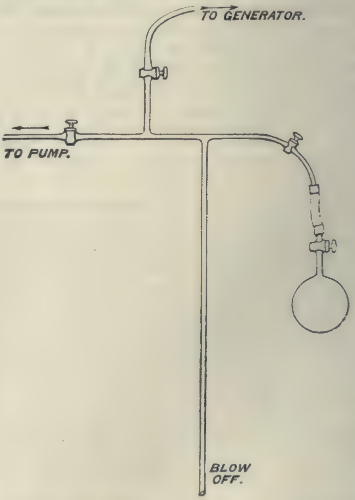
Except for the reversal of the electric current, the action of the apparatus is almost the same whether oxygen or hydrogen is to be collected. In the latter case the copper in the hot tubes is in the reduced, and in the former case in the oxidized, state. For the sake of distinctness we will suppose that the globe is to be filled with hydrogen.

The generator itself is of the U-form, with unusually long branches, and it is supplied from Grove cells with about 3 amperes of electric current. Since on one side the oxygen blows off into the air, the pressure in the generator is always nearly atmospheric. Some trouble has been caused by leakage between the platinum electrodes and the glass. In the later experiments to be here recorded these joints were drowned with mercury. On leaving the generator the hydrogen traverses a red-hot tube of hard glass charged with copper,[2] then a flask containing a strong solution of potash, and afterwards a second similar hot tube. The additional tube was introduced with the idea that the action of the hot copper in promoting the union of the hydrogen with its oxygen contamination might be more complete after removal of the greater part of the oxygen, whether in the combined or in the uncombined state. From this point onward the gas was nearly dry. In the earlier experiments the junctions of the hard furnace tubes with the soft glass of the remainder of the apparatus were effected by fusion. One of these joints remained in use, but the others were replaced by india-rubber connexions *drowned in mercury*. It is believed that no leakage occurred at these joints; but as an additional security a tap was provided between the generator and the furnace, and was kept closed whenever there was no forward current of hydrogen. In this way the liquid in the generator would be protected from any possible infiltration of nitrogen. Any that might find its way into the furnace tubes could easily be removed before the commencement of a filling.

Almost immediately upon leaving the furnace tubes the gas arrives at a tap which for distinctness may be called the regulator. In the generator and in the furnace tubes the pressure must be nearly atmospheric, but in the globe there is (at the commencement) a vacuum. The transition from the one pressure to the other takes place at the regulator, which must be so adjusted that the flow through it is approximately equal to the production of gas. At first the manipulation of the regulator was a source of trouble, and required almost constant attention, but a very simple addition gave the desired control. This was merely a long wooden arm, attached to the plug, which served both as a lever and as an indicator. Underneath the pointed extremity was a small table to which its motions could be referred. During the first two-thirds of a filling very little readjustment was needed, and the apparatus could be left for half an hour with but little fear of displacing too much the liquid in the generator. Towards the close, as the motive force fell off, the tap required to be opened more widely. Sometimes the recovery of level could be more conveniently effected by insertion of resistance into the electric circuit, or by interrupting it altogether for a few minutes. Into details of this kind it is hardly necessary to go further.

From the regulator the gas passed to the desiccating tubes. The first of these was charged with fragments of solid potash, and the second with a long length of phosphoric anhydride. Finally, a tube stuffed with glass wool intercepted any suspended matter that might have been carried forward.

The connection of the globe with the generator, with the Töppler, and with the blow-off, is shown in the accompanying figure. On the morning of a projected filling the vacuous globe would be connected with the free end of the stout-walled india-rubber tube, and secured by winding wire. The generator being cut off, a high vacuum would be made up to the tap of the globe.



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[1] At the suggestion of Prof. Morley, the solution was freed from carbonate or nearly so, by the use of baryta, of which it contained a slight excess.

[2] The copper must be free from sulphur; otherwise the contamination with sulphuretted hydrogen is somewhat persistent.

After a couple of hours' standing the leakage through the india-rubber and at the joints could be measured. The amount of the leakage found in the first two hours was usually negligible, considered as an addition to a globeful of hydrogen, and the leakage that would occur in the hours following would (in the absence of accidents) be still smaller. If the test were satisfactory, the filling would proceed as follows:—

The electric current through the generator being established, and the furnace being heated, any oxygen that might have percolated into the drying tubes had first to be washed out. In order to do this more effectively, a moderate vacuum (of pressure equal to about 1 inch of mercury) was maintained in the tubes and up to the regulator by the action of the pump. In this way the current of gas is made very rapid, and the half-hour allowed must have been more than sufficient for the purpose. The generator was then temporarily cut off, and a high vacuum produced in the globe connection and in the blow-off tube, which, being out of the main current of gas, might be supposed to harbour impurities. After this the pump would be cut off, the connection with the generator re-established, and, finally, the tap of the globe cautiously opened.

The operation of filling usually occupied from two to three hours. When the gas began to blow off under an excess of pressure represented by about half an inch of mercury, the blow-off cistern was lowered so as to leave the extremity of the tube free. For two minutes the current of gas from the generator was allowed to flow through, after which the generator was cut off, and the globe left in simple communication with the atmosphere, until it was supposed that equilibrium of pressure had been sufficiently established. Doubts have at various times been felt as to the interval required for this purpose. If too little time is allowed, there will remain an excess of pressure in the globe, and the calculated weight of the filling will come out too high. On the other hand, an undue prolongation of the time might lead to a diffusion of air back into the globe. In a special experiment no abnormal weight was detected after half an hour's communication, so that the danger on this side appeared to be small. When the passages through the taps were free from grease, one or two minutes sufficed for the establishment of equilibrium, but there was always a possibility of a partial obstruction. In the results to be presently given, four minutes were allowed after the separation from the generator. It may be remarked that a part of any minute error that may arise from this source will be eliminated in the comparison with oxygen, which was collected under like conditions.

The reading of the barometers and thermometers at the moment when the tap of the globe was turned off took place as described in the former paper. The arrangements for the weighings were also the same.

In the evacuations the process was always continued until, as tested by the gauge of the Töppler after at least a quarter of an hour's standing, the residue could be neglected. Here, again, any minute error would be eliminated in the comparison of the two gases.

In the case of oxygen, the errors due to contamination (even with hydrogen) are very much diminished, and similar errors of weighing tell very much less upon the proportional agreement of the final numbers. A comparison of the actual results with the two kinds of gas does not, however, show so great an advantage on the side of the oxygen as might have been expected. The inference appears to be that the individual results are somewhat largely affected by temperature errors. Two thermometers were, indeed, used (on opposite sides) within the wooden box by which the globe is surrounded, and they could easily be read to within $\frac{1}{20}$° C. But in other respects, the circumstances were unfavourable, in consequence of the presence in the same room of the furnace necessary to heat the copper. An error of ± 0°·1 C. in the temperature leads to a discrepancy of 1 part in 1500 in the final numbers. Some further elaboration of the screening arrangements actually employed would have been an improvement, but inasmuch as the circumstances were precisely the same for the two gases, no systematic error can here arise. The thermometers were, of course, the same in the two cases.

The experiments are grouped in five sets, two for oxygen and three for hydrogen. In each set the work was usually continued until the tap of the globe required re-greasing, or until, owing to a breakage or to some other accident, operations had to be suspended.

The means are as follow:—

HYDROGEN.

1891.	Weight.	Bar. temp., F.	Globe temp., C.	Corrected to 12°.
	gram.	°	°	gram.
July	0·15808	65	18	0·158056
September	0·15797	61	17	0·157950
October	0·15804	53	12	0·158040
Mean		60	16	0·158015

OXYGEN.

1891.	Weight.	Bar. temp., F.	Globe temp., C.	Corrected to 12°.
	grams.	°	°	grams.
June..............	2·51785	68	20	2·51735
November	2·51720	55	13	2·51713
Mean		61½	16½	2·51724

The means here exhibited give the weights of the two gases as they would be found with the globe at 12° C., and the barometers at 60° F. and at 30 inches. The close agreement of the mean temperatures for the two gases shows how little room there is for systematic error dependent upon imperfections in the barometers and thermometers. But the results still require modification before they can be compared with the view of deducing the relative densities of the gases.

In the first place, there is a systematic, though minute, difference in the pressures hitherto considered as corresponding. The terminal of the blow-off tube is 33 inches below the centre of the globe at the time of filling. In the one case this is occupied by hydrogen, and in the other by oxygen. If we treat the latter as the standard, we must regard the hydrogen fillings as taking place under an excess of pressure equal to $\frac{15}{16}$ of the weight of a column of oxygen 33 inches high; and this must be compared with 30 inches of mercury. Hence, if we take the sp. gr. of oxygen under atmospheric conditions at 0·0014, and that of mercury at 13·6, the excess of pressure under which the hydrogen was collected is as a fraction of the whole pressure

$$\frac{33}{30} \cdot \frac{15}{16} \cdot \frac{0·0014}{13·6} = 0·000106;$$

and 0·000106 × 0·158 = 0·000017. This, then, is what we must subtract from the weight of the hydrogen on account of the difference of pressures due to the gas in the blow-off tube. Thus

$$H = 0·157998, \qquad O = 2·51724.$$

But there is still another and a more important correction to be introduced. In my former paper it was shown that when the weighings are conducted in air the true weight of the gas contained in the globe is not given by merely subtracting the weight of the globe when empty from the weight when full. When the globe is empty, its external volume is less than when full, and thus, in order to obtain the true weight, the apparent weight of the gas must be increased by the weight of air whose volume is equal to the change of volume of the globe.

In order to determine the amount of this change of volume, the globe is filled to the neck with recently boiled distilled water, and the effect is observed upon the level in the stem due to a suction of, say, 20 inches of mercury. It is not advisable to carry the exhaustion much further, for fear of approaching too nearly the point at which bubbles of vapour may be formed internally. In the earlier experiments, described in the preliminary note, the upper surface of the liquid was in the stem of the globe itself (below the tap), and the only difficulty lay in the accurate estimation of a change of volume occurring in a wide and somewhat irregular tube. The method employed was to produce, by introduction of a weighed quantity of mercury, a rise of level equal to that caused by the suction.

The advantage of this procedure lay in the avoidance of joints and of the tap itself, but, for the reasons given, the readings were not quite so accurate as might be desired. I wished, therefore, to supplement, if possible, the former determination by one in which the change of volume occurred in a tube narrower and of better shape. With this object in view, the stem of the globe was prolonged by a graduated tubular pipette attached with the aid of india-rubber. The tubes themselves were treated with gutta-percha cement, and brought almost into contact. It had hardly been expected that the joint would prove unyielding under the applied suction, but it was considered that the amount of the yielding could be estimated and allowed for by operations conducted *with tap closed*. The event, however, proved that the yielding at the joint was scarcely, if at all, perceptible.

The pipette, of bore such that 16 cm. corresponded to 1 c.c., was graduated to 0·01, and was read by estimation to 0·001 c.c. In order the better to eliminate the changes due to temperature, readings under atmospheric pressure, and under a suction of 20 inches of mercury, were alternated. On January 28, 1892, a first set gave 0·648 − 0·300 = 0·348; a second gave 0·6645 − 0·316 = 0·3485; and a third gave 0·675 − 0·326 = 0·349. Similar operations with tap closed[1] gave no visible movement.

The result of the day's experiments was thus 0·3485 for 20 inches, or 0·523 for 30 inches, suction. Similar experiments on January 28, at a different part of the graduation, gave 0·526. On this day the yielding with tap closed was just visible, and was estimated at 0·001. As a mean result, we may adopt 0·524 c.c. The graduation of the pipette was subsequently verified by weighing a thread of mercury that occupied a measured length.

A part of the above-measured volume is due to the expansion of the water when the pressure is relieved. We may take this at 0·000047 of the volume per atmosphere. The volume itself may be derived with sufficient accuracy for the present purpose from the weight of its oxygen contents. It is 2·517/0·00137, or 1837 c.c. The expansion of the water per atmosphere is thus 0·000047 × 1837, or 0·087 c.c. This is to be subtracted from 0·524, and leaves 0·437 c.c. This number applies strictly to the volume inclosed within the glass, but the change in the external volume of the globe will be almost the same.

The correction now under consideration is thus the weight of 0·437 c.c. of air at the average temperature of the balance room. The density of this air may be estimated at 0·00122; so that the weight of 0·437 c.c. is 0·000533 gram. This is the quantity which must be added to the apparent weights of the gases. The former estimate was 0·00056 gram. The finally corrected weights are thus—

$$H = 0·158531, \qquad O = 2·51777;$$

and for the ratio of densities we have

$$15·882.$$

This corresponds to a mean atmospheric condition of pressure and temperature.

If we combine the above ratio of densities with Prof. Morley's ratio of volumes, viz. 2·0002 : 1, we get, as the ratio of atomic weights, 15·880.

If we refer to the table, we see that the agreement of the first and third series of hydrogen weighings is very good, but that the mean from the second series is decidedly lighter. This may have been in part fortuitous, but it is scarcely probable that it was so altogether. Under the circumstances we can hardly reckon the accuracy of the final results as closer than $\frac{1}{3000}$.

The accompanying table of results, found by various experimenters, may be useful for comparison:—

Name.	Date.	Atomic weights.	Densities.
Dumas	1842	15·96	—
Regnault	1845	—	15·96
Rayleigh	1888	—	15·884
Cooke and Richards ...	1888	15·869	—
Keiser	1888	15·949	—
Rayleigh	1889	15·89	—
Noyes	1890	15·896	—
Dittmar	1890	15·866	—
Morley	1891	15·879	—
Leduc	1891	—	15·905
Rayleigh	1892	—	15·882

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[1] For greater security the tap was turned while the interior was under suction.

THE ORIGIN OF THE YEAR.[1]

II.

Difficulties.

There no doubt was a time when the Egyptian astronomer-priests imagined that, by the introduction of the 365-days year, beginning at the solstice or the nearly contemporaneous Nile flood (there is an interval of three days between them in the present Coptic calendar[2]), and by marking the commencement, in addition, by the heliacal rising of one of the host of heaven, they had achieved finality. But alas! the dream must soon have vanished.

Even with this period of 365 days, the true length of the year had not been reached; and soon, whether by observations of the beginning of the inundation, or by observations of the solstice in some of the solar temples which, beyond all doubt, were then in existence, it was found that there was a difference of a day every four years between the beginning of the natural and of the newly-established year, arising, of course, from the fact that the true year is 365 days *and a quarter of a day* (roughly) in length.

The true year and this established year of 365 days, then, behaved to each other as follows. Let us take a year when the solstice, representing the beginning of the

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[1] Continued from vol. xlv. p. 490.

[2] The calendar in question (given both by Brugsch and De Rougé) is, doubtless, a survival from old Egyptian times. It is good for the neighbourhood of Cairo, and the relation of the important days of the inundation to the solstice, in that part of the river, is as follows:—

Night of the drop	11 Payni	
	15 ,, ...	Summer solstice.
Beginning of the inundation ...	18 ,, ...	3 days after.
Assembly at the Nilometer ...	25 ,, ...	10 ,,
Proclamation of the inundation ...	26 ,, ...	11 ,,
Marriage of the Nile	18 Mesori ...	63 ,,
The Nile ceases to rise...	16 Thoth ...	96 ,,
Opening of the dams	17 ,, ...	97 ,,
End of the greater inundation ...	7 Phaophi ...	117 ,,

true year, occurred on the 1st Thoth of the established year. We should have, in the subsequent years, the state of things described in the diagram. The solstice would year by year occur *later* in relation to the 1st of Thoth. The 1st of Thoth would occur *earlier*, in relation to the solstice; so that in relation to the established year the solstice would sweep forwards among the days; in relation to the true year the 1st of Thoth would sweep backwards.

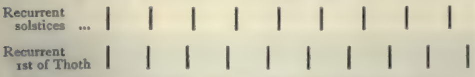

FIG. 2.—Showing the relation between the recurrences of the solstices and the 1st of Thoth.

Let us call the true natural year a *fixed* year: it is obvious that, the months of the 365-day year would be perpetually varying their place in relation to those of the fixed year. Let us, therefore, call the 365-day year a *vague* year.

Now if the fixed year were exactly 365¼ days long, it is quite clear that, still to consider the above diagram, the 1st of Thoth would again coincide with the solstice in 1460 years, since in 4 years the solstice would fall on the 2nd of Thoth, in 8 years on the 3rd of Thoth, and so on (365 × 4 = 1460).

But the fixed year is not 365¼ days long *exactly*. In the time of Hipparchus 365·25 did not really represent the true length of the solar year; instead of 365·25 we must write 365·242392—that is to say, the real length of the year is a little *less* than 365¼ days.

Now the length of the year being a little *less*, of course we should only get a second coincidence of the 1st of Thoth vague with the solstice in a *longer* period than the 1460-years cycle; and, as a matter of fact, 1506 years are required to fit the months into the years with this slightly shortened length of the year. In the case of the solstice and the vague year, then, we have a cycle of 1506 years.

The variations between the fixed and vague years were known perhaps for many centuries to the priests alone. They would not allow the established year of 365 days, since called the *vague* year, to be altered; and so strongly did they feel on this point that, as already stated, every king had to swear when he was crowned that he would not alter the year. We can surmise why this was. It gave great power to the priests; they alone could tell on what particular day of what particular month the Nile would rise in each year, because they alone knew in what part of the cycle they were; and in order to get that knowledge they had simply to continue going every year into their Holy of Holies one day in the year as the priests did afterwards in Jerusalem, and watch the little patch of bright sunlight coming into the sanctuary. That would tell them exactly the relation of the true solar solstice to their year; and the exact date of the inundation of the Nile could be predicted by those who could determine observationally the solstice, but by no others.

But now suppose that instead of the solstice we take the heliacal rising of Sirius, and compare the successive risings at the solstice with the 1st of Thoth.

But why, it will be asked, should there be any difference in the length of the cycles depending upon successive coincidences of the 1st of Thoth with the solstice and the heliacal rising of Sirius? The reason is that stars change their places, and the star to which they trusted to warn them of the beginning of a new year was, like all stars, subject to the effects brought about by the precession of the equinoxes. Not for long could it continue to rise heliacally either at the solstice or the Nile flood.

Among the most important contributors to the astronomical side of this subject are M. Biot and Prof. Oppolzer. It is of the highest importance to bring together the fundamental points which have been made out by their calculations. We have determinate references to the heliacal rising of Sirius, to the 1st of Thoth, to the solstice, and to the rising of the Nile in connection with the Egyptian year; but, so far as I have been able to make out, we find nowhere at present any sharp reference to the importance of their correlation with the times of the *tropical* year at which these various phenomena took place. The question has been complicated by the use by chronologists of the Julian year in such calculations; so the Julian year and the use made of it by chronologists have to be borne in mind. Unfortunately, many side issues have in this way been raised.

The heliacal rising of Sirius, of course—if in those days a true *tropical* year was being dealt with—would have given us a more or less constant variation in the time of the rising over a long period, *on account of its precessional movement;* but M. Biot and others before him have pointed out that the variation in the time of the year at which the heliacal rising took place, produced by that movement, was almost exactly equal to the error of the *Julian* year as compared with the true tropical or Gregorian one. Biot showed by his calculations, using the solar tables extant before those of Leverrier, that from 3200 B.C. to 200 B.C. in the Julian year of the chronologists, Sirius had constantly, in each year, risen heliacally on July 20 Julian = June 20 Gregorian. Oppolzer, more recently, using Leverrier's tables, has made a very slight correction to this, which, however, is practically immaterial for the purposes of a general statement. He shows that in the latitude of Memphis, in 1600 B.C., the heliacal rising took place on July 18·6, while in the year 0 it took place on July 19·7, both Julian dates.

The variation from the true tropical year brought about by the precessional movement of Sirius or any other star, however, can be watched by noting its heliacal rising in relation to any physical phenomenon which marks the true length of the tropical year. Such a phenomenon we have in the rising of the Nile, which, during the whole course of historical time, has been found to rise and fall with absolute constancy in each year, the initial rise of the waters, some little way above Memphis, taking place very nearly at the summer solstice.

Again, M. Biot has made a series of calculations from which we learn that the heliacal rising of Sirius AT THE SOLSTICE occurred on July 20 (Julian) in the year 3285 B.C., and that in the year 275 B.C. the *solstice* occurred on June 27 (Julian), while the heliacal *rising of Sirius* took place, as before, on July 20 (Julian), so that in Ptolemaic times, at Memphis, there was a difference of time of about 24 days between the heliacal rising of Sirius and the solstice, and therefore the beginning of the Nile flood in that part of the river. This, among other things, is shown in Fig. 3.

We learn from the work of Biot and Oppolzer then that the precessional movement of the star caused successive heliacal risings of Sirius at the solstice to be separated by almost exactly 365¼ days—that is, by a greater period than the length of the true year. So that, in relation to this star, two successive heliacal risings at the 1st of Thoth vague are represented by a period of (365¼ × 4 =) 1461 years, while in the case of the solstices we want 1506.

Now in books on Egyptology the period of 1461 years is termed the Sothic period, and truly so, as it very nearly correctly measures the period elapsing between two heliacal risings at the solstice (or the beginning of the Nile flood) on the 1st of Thoth in the *vague* year.

But it is merely the result of *chance* that 365¼ × 4 represents it. It has been stated that this period had not any ancient existence, but was calculated back in later times. This seems to me very improbable. I look upon it rather as a true result of observation, the more so as the period was shortened *in later times*, as Oppolzer has shown.

It will be seen that our investigations land us in several astronomical questions of the greatest interest, and that the study is one in which modern computations, with the great accuracy which the work of Leverrier and others give to them, can come to the rescue, and eke out the scantiness of the ancient records.

To consider the subject further, we must pass from the mere question of the year to that of chronology generally, but in doing so I shall limit myself to the more purely astronomical part. To go over the already vast literature is far from my intention, nor is it necessary to attempt to settle all the differences of opinion which exist, and which are so ably referred to by Krall in his masterly analysis, to which I own myself deeply indebted. The tremendously involved state of the problem may be gathered from the fact that the authorities are not yet decided whether many of the dates really belong to a fixed or a vague year!

Let us, rather, put ourselves in the place of the old Egyptians, and inquire how, out of the materials they had at hand, a calendar could be constructed in the simplest way.

To make what follows clearer, it will be well to construct another diagram somewhat like the former one.

Let us map out the 1460 years which elapsed between two successive coincidences between the 1st of Thoth in the vague year and the heliacal rising of Sirius at the solstice, so that we can see at a glance the actual num-

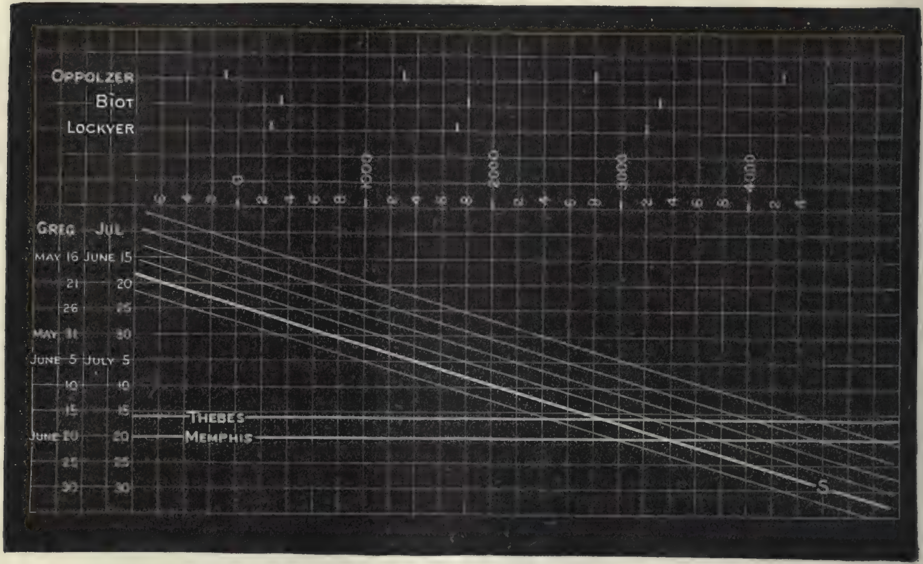

Fig. 3.—The conditions of the heliacal rising of Sirius from 4000 B.C. to 600 A.D. The diagram shows (1) by white horizontal lines, the Gregorian and Julian dates for the rising at Thebes and at Memphis. (2) By the full diagonal line the *Julian* date of the solstice or beginning of the inundation in each century, at a point of the river near Memphis. The fainter lines show the Julian dates for other places where the time of the beginning of the flood differs by three days from the Memphis dates. The interval between each line represents a difference of three days in the arrival of the flood (3) The interval in days between the heliacal rising and the inundation at different periods and at different points on the river. This can be determined for each century by noticing the interval between the proper diagonal line and that indicating the heliacal rising. (4) By dots at the top of the diagram the commencement of the Sothic period as determined by Oppolzer, Biot, and the author.

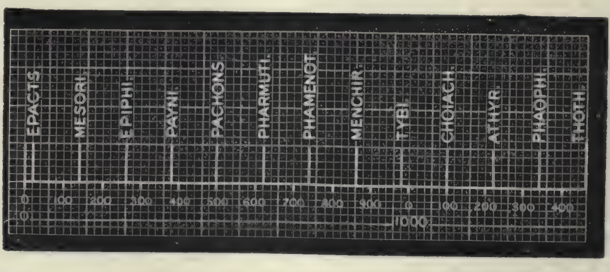

Fig. 4.—The distribution of the 1st of Thoth (representing the rising of Sirius) among the Egyptian months in the 1460-year Sothic cycle.

ber of years from any start point (= 0) at which the 1st of Thoth in the vague year occurred successively further and further from the heliacal rising, until at length, after a period of 1460 years, it coincided again.

As the Sirius-year is longer than the vague one, the first vague year will be completed before the first Sirius-year, hence the second vague year will commence just before the end of the fixed year, and that is the reason that I have reversed the order of months in the diagram (Fig. 4).

Now it is clear that, if the Egyptians really worked in this fashion, any special day in the vague year given as the date of the heliacal rising of Sirius would enable us to determine the number of years which had elapsed from the beginning of the cycle. This will help us to determine whether or not they acted on this principle, or used one widely different. In such an investigation as this, however, we are terribly hampered by the uncertainty of Egyptian dates; while, as I have said before, there is great divergence of opinion among Egyptologists as to whether, from very early times, there was not a true fixed year.

But let us suppose that the vague year was in use, and that the rising of Sirius started the year; then, if we can get any accepted date to work with, and use the diagram to see how many years had elapsed between that date and the start-point of the cycle, we shall see if there be any cyclical relation, and if we find it, it will be evidence, so far as it goes, of the existence of a vague year.

Now it so happens that there are three references, with dates given, to the rising of Sirius in widely different times; and, curiously enough, the month references are nearly the same. I begin with the most recent, as in this case the date can be fixed with the greater certainty. It is an inscription at Philæ, described by Brugsch (p. 87), who states that, when it was written, the 1st of Thoth = 28th of Epiphi. That is, according to the view we are considering, the heliacal rising of Sirius occurred on the 28th of Epiphi in the vague year. He fixes the date of the inscription between 127 and 117 B.C. Let us take it as 122. Next, referring to our diagram to find how many years had elapsed since the beginning of the cycle, we have—

Days.
5 Epacts.
30 Mesori.
2 Epiphi.
—
$37 \times 4 = 148$ years elapsed.

The cycle, then, began in $(148 + 122 =)$ 270 B.C.

We next find a much more ancient inscription recording the rising of Sirius on the 28th of Epiphi. Obviously, if the Sothic cycle had anything to do with the matter, this must have happened 1458 years earlier, *i.e.* about $(1458 + 122 =)$ 1580 B.C. Under which king? Thotmes III., who reigned, according to Lepsius, 1603–1565 B.C.; according to Brugsch, 1625–1577. Now, the inscription in question is stated to have been inscribed by Thotmes III., and, it may be added, on the temple (now destroyed) at Elephantiné.

There is yet another inscription, also known to be of a still earlier period, referring to the rising of Sirius on the 27th of Epiphi. We may neglect the difference of one day; and again, if the use of the Sothic cycle were the origin of the identity of dates, we have this time, according to Oppolzer, a period of 1460 years to add: this gives us $(1584 + 1460 =)$ 3044 B.C. Again under which king? Here we are face to face with one of the difficulties of these inquiries. It may be stated, however, that the inscription is ascribed to Pepi, and that, according to various authorities, he reigned some time between 3000 and 3700 B.C.

We come, then, to this: that one of the oldest dated inscriptions known seems to belong to a system which continued in use at Philæ up to about 100 B.C., and it was essentially a system of a vague year.

Now, assuming that the approximate date of the earliest inscription is 3044 B.C., and that it represented the heliacal rising of Sirius on the 27th of Epiphi; the year 3044 must have been the $[(5 + 30 + 3) \times 4 =]$ 152nd after the beginning of the cycle. The cycle, then, must have commenced $(3044 + 152 =)$ 3196 B.C.

According to Biot's calculation, the first heliacal rising of Sirius at the solstice took place in the year 3285 B.C.,

If we assume that the real date of Pepi, who, it is stated, reigned 100 years, included the year 3044 B.C., it may be that the inscriptions to which I have directed attention give us three Sothic cycles beginning—

$122 + 148 = 270$ B.C.
$1580 + 148 = 1728$ B.C.
$3044 + 148 = 3192$ B.C.

J. NORMAN LOCKYER.

(*To be continued.*)

NOTES.

THE list of those on whom honorary degrees are to be conferred at Cambridge on the occasion of the installation of the Duke of Devonshire as Chancellor shows that culture, and especially scientific culture, goes for very little among the classes of distinction recognized by the University. Eminence in the political world and in society seems to be the claim chiefly recognized.

SCIENCE was well represented at the annual dinner of the Incorporated Society of Authors on Tuesday. The chair was occupied by Prof. Michael Foster, and Sir Archibald Geikie was one of those who responded to the toast of "Literature."

DR. A. F. BATALIN has been appointed Director of the Imperial Botanic Garden at St. Petersburg, in succession to the late Dr. E. Regel.

THE ninety-seventh meeting of the Yorkshire Naturalists' Union will be held on Whit Monday, June 6. Some interesting notes on the physical geography and geology, botany, entomology, conchology, and vertebrate zoology of the district have been issued for the benefit of those who intend to be present. We are glad to see that members are expected to "do all in their power to discourage the uprooting of ferns and rare plants, or the too free collection of rarities of any kind."

THE Botanical Society of France has held its annual meeting at Algiers, commencing April 16, under the presidency of the Algerian botanist, M. Battandier. In addition to the reading of papers, excursions were made to Biskra, and other spots on the border of the Sahara.

WE have received the programme of the ninth International Congress of Orientalists. It is to be held in London from September 5 to 12, Prof. Max Müller acting as President. The Duke of Connaught has accepted the office of Honorary President. The following are the Vice-Presidents: the Marquis of Ripon, Lord Northbrook, Lord Reay, Major-Gen. Sir Henry Rawlinson, the Rt. Hon. Sir M. E. Grant Duff, Sir John Lubbock, Sir William Muir, Sir William W. Hunter, Sir George Birdwood, Sir William Markby, Sir Edwin Arnold, the Provost of Oriel College, Oxford, the Master of Balliol College, Oxford, the Master of Christ's College, Cambridge, H. S. King, and M. M. Bhownuggree. The Treasurer is Mr. E. Delmar Morgan. The Honorary Secretaries are: the Rev. C. D. Ginsburg, D.D., Prof. T. W. Rhys Davids, the Rev. E. W. Bullinger, D.D., Prof. A. A. Macdonell, M. M. Bhownuggree, the Raja Peari Mohan Mukharji (for Bengal), Prof. Peterson (for Bombay). Many eminent foreign scholars and members of former Congresses have signified their adhesion, and several important Societies have undertaken to send delegates. The sections into which the work of the Congress has been provisionally divided, are the following (the name of the President being in each case given first, that of the Secretary second):—I. Aryan, Prof. Cowell, Prof. A. A. Macdonell; II. Semitic (*a*) Assyrian and Babylonian, Prof. A. H. Sayce, T. G. Pinches, (*b*) General, Prof. Robertson Smith, A. A. Bevan; III. China and the Far East, Sir Thomas Wade, (for China) Prof. Douglas, (for Japan) Prof. B. H. Chamberlain; IV. Egypt and Africa, Prof. Le Page Renouf, E. Budge; V. Australasia and Oceania, Sir Arthur Gordon, Rev. R. H. Codrington, D.D.; VI. Anthropological and Mythological, Dr. E. B. Tylor; VII. Indian, Lord Reay, Prof. T. W. Rhys Davids; VIII. Geographical, Sir M. E. Grant Duff, Halford J. Mackinder; IX. Archaic Greece and the East, the Rt. Hon. W. E. Gladstone.

THE Committee of the two International Congresses of Prehistoric Archæology and Zoology, which will be held at Moscow this summer in connection with the Geographical and Anthropological Exhibition, has announced, in accordance with a decision of the Russian Railway Department, that all members of the Congresses and exhibitors at the Exhibition may obtain tickets with a 50 per cent. reduction for travelling to Moscow and back. Exhibits may be sent and will be returned on the same terms. As there are at Moscou two different Societies, the Société des Naturalistes de Moscou and the Society of Friends of Natural Science (*Obschestvo Lubitelei Estestvoznaniya*), it may be worth while to note that it is the latter which is organizing the Exhibition and the two Congresses, and to which all applications for the Exhibition must be made.

IT is stated that the Secretary of State for the Colonies has appointed Miss Doberck, formerly Government Meteorological Observer in Sligo, to be Assistant Meteorologist in Hong Kong. Miss Doberck's father has for some years past been the head of the Meteorological Observatory in Hong Kong.

LIEUTENANT-COLONEL HOLDICH, of the Survey of India, will, it is said, personally superintend the mapping out of Captain Bower's journey across Tibet. The work will be done in the Survey drawing offices at Simla, where Captain Bower is at present engaged in preparing the report of his journey.

IT is bad news for farmers that the diamond-back moth has made its appearance in Yorkshire and Northumberland. Specimens from both counties have been identified by Miss Ormerod.

THE weather during the past week has been noteworthy for the occurrence of thunderstorms, copious rainfall at nearly all places, and excessive temperatures at most of the English stations. In London a severe thunderstorm was experienced on Thursday morning, May 26 (succeeding one that occurred the previous evening), with a heavy downpour of rain varying from 0·7 inch to 1·0 inch in different parts of the metropolis. At 8h. a.m. on Saturday the thermometer registered 76° in London, being the highest recorded at that hour this year. The type of wind has been cyclonic, with light or moderate south-westerly breezes generally. The Meteorological Office report for the week ending May 28, shows that the rainfall was equal to the normal value in the south and east of England, and exceeded it in all other districts; while in the northern parts, in Ireland and in Scotland, the fall was about three times as much as the mean. On Sunday the temperature was considerably lower, but since then it has again become abnormally high, the maxima in the shade registering 75° and upwards in places over the southern parts of the kingdom, 83° being registered in London on Tuesday; and thunder-showers occurred in various places on that day.

THE detailed despatches brought to Marseilles from Port Louis by the mail steamer *Australien* confirm all that was stated in the telegrams relating to the hurricane which devastated Mauritius on April 29. A Reuter's telegram from Marseilles, giving a summary of the despatches, says that the total number of lives lost amounted to 1200, while the list of persons injured exceeded 4000. Strong magnetic disturbances were noticed on April 25, and continued with increasing intensity on the three following days. Several well-defined groups of sun-spots were also noticed at the same time. On the afternoon of the 28th, the eve of the hurricane, there was a vivid display of lightning and a good deal of thunder, while the air grew peculiarly heavy. On the following morning the tempest broke over the island in all its fury, the velocity of the wind at times reaching 112 miles an hour. The sea rose 9 feet above its usual level, a thing unknown since the terrible cyclone of 1818, when the water rose nearly four metres. In Port Louis itself houses fell to the ground in nearly every street. In the Tringlar quarter not a single house was left standing. In fact, there is scarcely a house in the entire colony which does not show some signs of the fury of the storm. Half the sugar crop has been destroyed. An immense number of persons were overwhelmed and killed by the ruins of the falling houses, or were stricken down in the streets, as they fled, by the falling stones and wreckage.

A VERY destructive cyclone passed over various towns in Kansas, on May 27. The storm gave no signs of its approach. Travelling in a north-easterly direction, it struck Wellington (a town containing a population of 10,000) at nine o'clock in the evening, when most people were indoors. Within a few seconds the central parts of the town coming within its track were devastated from end to end. Wellington Avenue, the principal business street, is lined on both sides with ruins, whole blocks of buildings having been shaken and overthrown as violently as if the place had been rocked by an earthquake. Numbers of victims were buried in the ruins, and of those who momentarily survived many were found struggling for their lives in order to escape from the flames which broke out in all directions in consequence of the sudden escape of gas. The towns of Harper and Argona were also visited by the cyclone. In the former town seven people were killed in the wreck of the buildings, and five at the latter. It is estimated that between twenty and thirty people lost their lives in the cyclone; while seventy others have been more or less injured.

ON Tuesday, May 3, a fall of hail mixed with foreign particles was observed in Stockholm, and appears to have extended as far as Christiania. The fall of dust lasted from 1 to 8 p.m., and was abundant enough to allow of considerable quantities being collected. At a meeting of the Geologiska Förening in Stockholm, remarks were made by Baron Nordenskiöld, and Messrs. N. Holst, E. Svedmark, and Törnebohm, from which it appears that the dust contained glassy, isotropic, and various anisotropic particles, hornblende, magnetite, minute scales of mica, metallic iron, and some diatoms.

THE Tiflis *Kavkaz* gives the following description of a meteor of great brilliancy which was observed at Tiflis, on May 10. It appeared at 11 p.m. in the west part of the sky, was of a round shape, and very brilliant. Three seconds after its appearance a part of it separated, moving towards the Mtatsminda Mountain, and disappeared below the horizon, after lighting the slopes of the mountain, the central meteor continuing to move, but having lost for a few seconds its great brilliancy, which, however, soon reappeared. In about 30 seconds after the first appearance of the meteor, a second small part separated from it, increasing in size as it approached the earth. This also disappeared in the west, behind the same mountain, after having brilliantly lighted for two or three seconds its slopes and gorges. After that, the meteor took first a milky coloration, but soon became bright again, and of phosphoric aspect. A third part separated from it, but it was much smaller and not so brilliant as the two former. Finally the meteor disappeared behind the clouds—a white, lighted blot being seen through them—and gradually faded away. The phenomenon lasted altogether about three minutes.

WE learn from the *Pioneer Mail* that a smart shock of earthquake was felt at Madras on May 6, about ten minutes to ten o'clock. The sound heard was at first like distant thunder, and afterwards like a railway train, running close by. The shock was distinctly felt. The weather was cloudy and the atmosphere still at the time.

THE *Annuaire Géologique universel*, founded by Dr. Dagincourt in 1885, and continued under the editorship of Dr. L. Carez for geology, and of M. H. Douvillé for palæontology, has now reached its seventh volume. Each year the work has increased in value, and it now affords an admirable *résumé* of geological literature. Hitherto each volume has been issued in a complete form, but the latest has appeared in four parts. By the arrangement adopted there is some repetition, but this enables information required to be readily obtained. There is first a fairly complete list of papers and other publications, then a systematic account of the various main chronological divisions of formations; this is followed by a description of separate districts; and finally we have a summary of palæontological work. The stratigraphical notes are not always complete in each volume, sometimes two years are grouped in one yearly issue; for instance, this volume contains no account of the Triassic and Tertiary rocks, whilst the Cretaceous works of 1890–91 are here included. The volume contains lists of geologists in France, Belgium, and the British Isles; next year we are promised lists for other European countries. The editors are assisted by a large staff of workers in various countries.

M. E. RIGAUX, of Boulogne-sur-Mer, who has devoted many years to the study of the geology of the Bas Boulonnais, has published an excellent account of this region in the *Mémoires de la Soc. Académ. de Boulogne* (vol. xiv., 108 pp.). The district is of especial interest to English geologists because of the fine development there of the Devonian and Carboniferous rocks, and of the Jurassic series from the Great Oolite upwards. The coal, formerly supposed to lie within the Carboniferous Limestone series, is now known to be true coal measures, over which the older rocks have been thrust. The paper gives an account of several important deep borings, in some of which Silurian rocks have been reached beneath the Jurassic series. Thirteen new species of fossils are described.

DURING the past season, Dr. Sheldon Jackson, the Government Agent of Education in Alaska, introduced into Alaska from Siberia sixteen reindeer. Next year he proposes to establish a herd of reindeer in the neighbourhood of Fort Clarence, and he expects to begin with 100 animals. The *Scientific American*, which records these facts, is of opinion that from an economical point of view the experiment is of the highest interest, because the reindeer is useful as a draught animal for sledges, as well as for its milk, its meat, and its skin. As it flourishes in Siberia, there seems to be no reason why it should not also flourish in Alaska, where the conditions of climate and vegetation are very similar to those of Siberia.

THE editors of the *Entomological Monthly Magazine* note that at the sale of the late Mr. Arthur Naish, of Bristol, at Stevens's Rooms on May 16, some of the extinct (or nearly extinct) species of British Lepidoptera fetched high prices. Seven examples of *Lycæna dispar* (the long extinct British form of *L. Hippothoë*) realized £16 8*s*., or an average of nearly £2 7*s*. each. A lot containing four *Polyommatus Acis* (perhaps extinct) was sold for 18*s*. Eight *Lælia cænosa* (apparently recently extinct) were sold for £3 17*s*. 6*d*. Two *Cleora viduaria* (not found very recently) were knocked down for a guinea. Seven *Noctua subrosea* (long extinct as British, and the continental form of which, *subcærulea*, is very different in appearance) obtained £6 12*s*., one very fine example realizing £2 10*s*.

MR. C. W. DALE, writing from Glanvilles Wootton, records, in the June number of the *Entomologist's Monthly Magazine*, that the effect of the weather upon insect life in Dorsetshire during April was remarkable. Butterflies were unusually plentiful, moths unusually scarce. The conclusion he draws is that easterly winds, with frosts at night, are injurious to moth life, but do not affect butterfly life, so long as there is plenty of blue sky and sunshine. These were the general meteorological conditions in Dorsetshire during April.

MESSRS. LONGMANS, GREEN, AND CO. have issued a new and revised edition (the third) of Mr. W. A. Shenstone's "Practical Introduction to Chemistry." It contains the practical introductory course of work in use at Clifton College. In this edition the author has made several changes which have been suggested by his own experience and that of various friends.

THE forty-fourth part of Cassell's "New Popular Educator" has been published. It includes two coloured maps, one of Asia Minor, the other of Palestine.

CYANIDE of arsenic, $As(CN)_3$, has been prepared by M. Guenez, and is described by him in the current number of the *Comptes Rendus*. It has been obtained by the action of finely divided elementary arsenic upon iodide of cyanogen, CNI, a substance which is usually obtained crystallized in delicate, transparent needles, frequently attaining the length of several inches. About thirty grams of perfectly dry cyanogen iodide were placed in a strong Wurtz flask, together with seven grams of powdered arsenic and sixty to seventy cubic centimetres of carbon bisulphide previously dried over phosphoric anhydride. The air contained in the flask was then displaced by dry carbon dioxide and the flask sealed. The reaction was found to commence in the cold, crystals of tri-iodide of arsenic soon making their appearance. But, in order to complete the conversion of the iodide of cyanogen into arsenic cyanide, it was found necessary to heat the flask for about twenty-four hours over a water-bath. The heating is best carried out in successive periods of seven or eight hours, allowing the flask to cool after each period and subjecting the contents to brisk agitation. Under these circumstances a quantitative yield of arsenic cyanide was obtained, in accordance with the following equation:—

$$2As + 3CNI = AsI_3 + As(CN)_3.$$

In order to isolate the cyanide, advantage was taken of its insolubility in carbon bisulphide, arsenic iodide being readily soluble. The product of the reaction was therefore placed in a continuous extracting apparatus, in which it was thoroughly exhausted with pure carbon bisulphide. The residual cyanide was subsequently dried in a current of carbon dioxide, and preserved in sealed tubes previously filled with the same indifferent gas.

CYANIDE of arsenic obtained in the manner above indicated is a slightly yellow substance consisting of small crystals, which under the microscope are observed to be well formed, and to possess a deep yellow colour by transmitted light. The crystals are extremely deliquescent, being instantly decomposed by water with production of arsenious oxide and prussic acid:

$$2As(CN)_3 + 3H_2O = As_2O_3 + 6HCN.$$

When heated, arsenic cyanide evolves about a third of its cyanogen in the form of gaseous di-cyanogen, the residue consisting of a mixture of free arsenic and paracyanogen. When brought in contact with concentrated sulphuric acid and slightly warmed, mutual decomposition occurs, with liberation of sulphur dioxide and carbon monoxide, the nitrogen remaining in the form of ammonium sulphate. Iodine reacts with arsenic cyanide in an energetic manner, even in the cold, forming iodides of arsenic and cyanogen without the volatilization of any iodine. With potassium chlorate, arsenic cyanide forms a mixture which detonates with considerable violence when struck.

The additions to the Zoological Society's Gardens during the past week include two Black-backed Jackals (*Canis mesomelas*) from South Africa, presented by Master Logan; two North African Jackals (*Canis anthus*), four —— Gerbilles (*Gerbillus* sp. inc.), an Egyptian Jerboa (*Dipus ægyptius*), six Leith's Tortoises (*Testudo leithii*), five Common Skinks (*Scincus officinalis*), an Egyptian Eryx (*Eryx jaculus*), a Schneider's Skink (*Eumeces schneideri*), two Crowned Snakes (*Zamenis diadema*), a Hissing Sand-Snake (*Psammophis sibilans*) from Egypt, presented by Dr. J. Anderson, F.R.S., F.Z.S.; a Cinerous Vulture (*Vultur monachus*) from Aden, presented by Mr. W. H. Still; a Common Peafowl (*Pavo cristatus* ♂) from India, presented by Colonel Bagot-Chester; two African Love-Birds (*Agapornis pullaria*) from West Africa, presented by Lady McKenna; a Chinese Goose (*Anser cygnoides* ♂) from China, presented by Miss Hill; two Common Vipers (*Vipera berus*), four Common Snakes (*Tropidonotus natrix*), a Slowworm (*Anguis fragilis*), British, presented by Mr. C. Browne; a Mocassin Snake (*Tropidonotus fasciatus*) from North America, presented by Master Denny Stradling; two Purple-capped Lories (*Lorius domicella*) from Moluccas, two Scaly-breasted Lorikeets (*Trichoglossus chlorolepidotus*) from Timor, deposited; four Common Sheldrakes (*Tadorna vulpanser*, 2 ♂, 2 ♀), four Ringed Doves (*Columba palumbarius*, 2 ♂, 2 ♀), European, purchased; two Black-eared Marmosets (*Hapale penicillata*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Winnecke's Periodic Comet, 1892.—The following ephemeris for this comet has been extracted from *Astronomische Nachrichten*, No. 3083. The comet itself is becoming decidedly brighter, and will be found just between the Great Bear and Leo Minor.

Berlin Midnight.

1892.	App. R.A. h. m. s.	App. Decl. ° ′ ″	log Δ.	log *r*.	Br.
June 2	10 50 23·4	+43 11 46·0	9·9949	9·5376	8·61
3	48 52·4	4 31·4			
4	47 16·4	42 56 59·7			
5	45 34·6	49 10·6			
6	43 46·4	41 2·7	9·9837	9·5012	10·72
7	41 50·7	32 34·0			
8	39 47·0	23 42·0			
9	37 34·4	14 23·5			

Saturn's Rings.—At the present time the earth may be said to be very nearly in the plane of Saturn's Rings, thus affording observers an opportunity of examining the ring from the sectional point of view. M. Bigourdan communicates to the *Comptes rendus* (No. 21) the results of a study he has just made, with reference to some peculiarities he has found to exist. The preceding arm of the ring, he says, presented nothing very abnormal, but it appeared to thin rather than thicken whilst approaching the planet. The amount of thinning in the case of the following arm was much more striking. At a distance of two-thirds of the length of the arm it commenced to leave the outside edge, continuing gradually, and producing "the appearance of a luminous angle, regular and very pointed, the apex of which joined to the disk of the planet." Observed again on May 21, the following arm showed a protuberance situated near Cassini's division. In M. Bigourdan's own words, the above appearances could be produced by an "elevation of the level edging the separation of Cassini, and producing on the opposite face a luminous pad which would nearly double the apparent thickness of the ring."

GEOGRAPHICAL NOTES.

Petermann's Mitteilungen for June contains the long-expected account of Emin Pasha's return expedition to the equatorial lakes, written by his companion, Dr. Stuhlmann. Leaving Kahura in March 1891, they traversed an unknown region to the southern shore of Lake Albert Edward, which they followed round its western side, and marched as far north as the Ituri in 2° 13′ N. Here the party had to turn. Emin met a number of his old followers living near Kavalli, on Lake Albert, and many of them joined his expedition. The return journey was disastrous. An outbreak of small-pox made it necessary to divide the expedition; Emin was left behind, while Stuhlmann went on with those able to travel and reached the German station of Bukoba on Lake Victoria in February 1892. The scientific observations made necessitate certain corrections on the map of this part of Africa. Mount Mfumbiro is further west than originally supposed, and may even lie within the boundaries of the Congo State. It is a volcanic chain, one of the peaks of which, Mount Virungo, is apparently still active. Stuhlmann gives the level of Lake Albert Edward as 2750 feet instead of 3307 as determined by Stanley.

Sir William Macgregor continues to give proofs of remarkable energy as an explorer, and of tact and skill as Administrator of British New Guinea. In the early part of this year he has been engaged in a series of journeys through the south-eastern districts of the possession, and everywhere he has found the natives peaceful and friendly. In a recent coasting trip he passed several islands, which at first sight appeared uninhabited, but on landing he discovered that this appearance was due to their singular configuration. A narrow belt of gently sloping land led from the sea to a steep wall of coral rock, from 300 to 400 feet high, from the summit of which an undulating plateau was seen dipping inland. Here the villages were built, from 50 to 100 feet below the level of the encircling rim, and sheltered from the trade-winds. Sir William considers these islands to be upraised atolls, modified in most cases by subsequent wave action on the shore strips.

Lieutenant T. H. Barnes, on behalf of the Bolivian Government and the Argentine Geographical Society, is investigating the navigability of the Rio Otuquis, a tributary of the Upper Paraguay, in the hope of opening a new route for Bolivian trade.

Lieutenant Mizon, compelled by the passive resistance of the Royal Niger Company to relinquish his projected journey by the Benué to Lake Chad, has (according to *La Politique Coloniale*) crossed the watershed to the Congo Basin, and on his way from the Benué to the Sangha, traversed the hinterland of the German Cameroon colony, one of the rapidly-shrinking blank spots on the map of Africa. Reports from Tripoli state that Captain Monteil is pushing on from Kano, in Sokoto, to Bornu and Lake Chad.

The collection of educational appliances, books, atlases, &c., made by Mr. J. Scott Keltie on behalf of the Royal Geographical Society in 1885, has been lent to the Teachers' Guild of Great Britain and Ireland, in whose rooms at 74 Gower Street it has been admirably arranged by Miss Busk. This collection, which after its original appearance in London was shown in most of the large towns in the country, has never been more effectively displayed. When first brought together, the inferiority of the British school atlases and text-books to the German and French productions was very marked; but during the last seven years English publishers have made great advances, and several of the newer and better publications have been added. It would be most desirable if the department of English books, maps, and geographical appliances could be made thoroughly representative, so that teachers would have a real opportunity of comparing the best work of 1892 with that which was current in 1885.

Mr. H. J. Mackinder, Reader in Geography at Oxford, has recently returned from a brief visit to the United States, where he has been devoting special attention to the state of the higher geographical teaching. In many respects the American Colleges are in advance of the corresponding institutions in this country, and geography is attracting increased attention on the part of some of the most energetic and progressive educationists.

COUNT PFEIL, who recently passed through London, *en route* for the Cape of Good Hope, is about to conduct a party of emigrants to Walfisch Bay, in the hope of colonising the adjacent parts of German South-West Africa.

Two pillars, erected by Diogo Cão, the first Portuguese explorer on the west coast of Africa, have recently been brought back to Lisbon. An interesting circumstance is the discovery on the pillar brought from Benguela of an inscription showing that the coast had been traced so far in 1482, two years earlier than the date usually assigned.

THE IRON AND STEEL INSTITUTE.

THE annual meeting of this institution was held on Thursday and Friday of last week, at the Institution of Civil Engineers, Sir Frederick Abel, the President, occupying the chair. After the reading of the Council's annual report Sir Frederick Abel delivered his Presidential address. He began with a reference to the losses which the Institute had sustained during the year by the death of some of its eminent members. He spoke especially of the solid services rendered to science by the late Duke of Devonshire. The Duke's wise munificence in the establishment of the Cavendish Laboratory in Cambridge University, and the important part he took in the labours of the Royal Commission on scientific instruction and the advancement of science, were described as "illustrations of his active participation in a movement of most vital importance to the maintenance of our position and influence among nations." Sir Frederick also referred to the Duke's ready consent to fill the post of first president of the Iron and Steel Institute as a proof of his appreciation of the high importance to be attached to the successful foundation of an organization of which he predicted that it would prove "a powerful instrument for the advancement and progress of the iron and steel trade of Great Britain, by promoting intercourse and interchange of knowledge between its members"—a prediction which was speedily and amply fulfilled. In his introductory address the Duke had discussed the development of iron-manufacture in most interesting and comprehensive fashion. In referring to the most extraordinary mineral wealth of the United States, he pointed out that although in 1867 the production of pig iron in America had risen to nearly 1,350,000 tons (of 2240 lbs.), the price of labour did not warrant the belief that there was any immediate prospect of the United States competing with the iron-producing countries of Europe in the open markets of the world.

Sir Frederick continued:—

A very interesting report upon the state of iron manufacture was presented by Sir Lowthian Bell to the British Association at its meeting in Dundee in 1867. A critical examination was made therein of the relative position of ourselves and Continental nations as iron manufacturers, *à propos* of the Paris International Exhibition of that year; but in the encouraging view which that eminent authority presented of our position at the period named he was not led to make any reference to the prominence which the United States were beginning to assume among iron-producing countries. After the lapse of twelve years, however, the production of pig iron in the States had been doubled, while in another ten years it had reached a figure approximating to the average production in Great Britain during the past ten years.[1]

Viewed from our present standpoint, the observations made by our first President in his opening address of 1867, regarding the development of the manufacture of steel, are very interesting. The Duke pointed out that, "owing to recent inventions and improvements, steel had acquired an importance greatly exceeding that which it previously possessed." After referring to the then prevalent views regarding the nature of steel, and to its production by the cementation process, the puddling and the mixing processes, and the partial decarbonisation of cast iron by blowing air into pig iron melted in a charcoal hearth, he dwelt upon the interest with which the development of the Bessemer process had been watched by the iron-making world, upon the *promise* "which that process afforded of furnishing a supply of steel suitable for many most important purposes upon a scale and at a price hitherto unknown," and upon the association of the names of Joseph Heath with the first employment of manganese in steel manufacture, and of Robert Mushet with the important part played by manganese-alloys in the development of the Bessemer process. While the approaching expiration of the first Bessemer patent was referred to as likely to tend to an increase in the demand for its products, the limits which the then existing knowledge placed upon the application of the process were pointed out, and the advantages of the puddling process dwelt upon. It is interesting to note that, at any rate in Germany, these advantages have not yet been dispelled, in spite of the great revolution which the Bessemer and open-hearth processes have effected in the applications of wrought iron and steel. On the other hand, the importance which steel had acquired through the practical development of the Bessemer-process, at the date of our first President's address, was but an indication of the new era upon which the iron and steel industries were about to enter. In that year the produce of Bessemer-steel in the United Kingdom was only 160,000 tons, while open-hearth steel was not yet a staple product; in 1890 the British production of Bessemer steel exceeded two millions of tons, while that of open-hearth steel exceeded 1·5 millions of tons.[1]

A statement made in the Duke's address of 1869, that, so far as existing knowledge went, the Bessemer process was of limited application, as only certain kinds of iron were susceptible of successful treatment by it, affords, by a comparison with the present condition of things, an interesting illustration of the continuous progress made in the successful application of advances in scientific knowledge to practical purposes. The success which crowned the efforts of Thomas, Gilchrist, Snelus, and others to render the Bessemer- and open-hearth processes efficient in their application to ores, the successful treatment of which by them appeared well-nigh hopeless in the earlier days of the Iron and Steel Institute's existence, has recently been very prominently before the public, and the members will certainly receive with special interest the communication which the Director of Naval Construction has promised us on experiments with basic steel.

In the discussion which took place at the meeting of the Institute of Naval Architects last year, *à propos* to a paper by M. J. Barba on recent improvements in armour plates, it became evident that the public were far better instructed as to progress made in such directions as this by other nations than as to advances made by ourselves; such information as Mr. White feels warranted in affording us with respect to our progress in practical experience on the merits of basic steel as applied to shipbuilding and other naval purposes will therefore be very welcome.

From the United States interesting accounts have reached us of a continuation of the experiments with armour plates 10½ inches thick, which were commenced at Annapolis in September 1890, when an all-steel and a nickel-steel plate, from the Creusot works, were contested in comparison with a compound plate of Cammel's make. Of these, the nickel-steel plate was considered to have shown itself somewhat superior to the all-steel plate, and very decidedly superior to the compound plate; and it is stated that Congress showed its appreciation of the importance of this result by appropriating a million dollars to the purchase of nickel ore. The second and third series of trials have been carried out at the Naval Ordnance Proof Ground at Indian Island, near Washington. The plates fired at in October last, constituting the second series of three, are described as a high carbon nickel-steel plate from the Bethlehem Iron Company, one of low carbon nickel-steel from Carnegie, Phipps, and Co.'s works at Pittsburg, and a so-called "Harveyised" plate of low carbon steel from the Bethlehem works. The description given of the Harveyising process identifies it as being a case-hardening or partial cementation treatment, the surfaces of the steel plate being hardened by carbonization (and by a supplementary chilling process), and the increase in carbon dying away towards the interior of the mass. In the trials of these plates, that of high carbon nickel-steel appears to have stood the best, but the effect of the Harveyising process upon the powers of resistance of the low carbon steel plate seems to have afforded indications of beneficial effect such as to warrant the application of the process to nickel-steel plates included in the third series, fired at last November, and which comprised a high carbon nickel-steel plate from Carnegie, Phipps, and Co., a low carbon Harveyised nickel-steel plate from the same makers, and a high cabon Harveyised nickel-steel plate from the Bethlehem Company. In all the nickel-steel plates, including that from Creusot tried in 1890, the amount of nickel in the metal appears to have been a little above 3 per cent.

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[1] Mr. Robert S. M'Cormick, Resident Commissioner for Great Britain for the Chicago Exhibition of 1893, in a paper recently communicated to the Society of Arts upon the future trade-relations between Great Britain and the United States, gives the following figures as demonstrating that the British iron and steel industry has been outstripped in magnitude by that of the United States. In 1890 the produce of pig iron in America was 9.202,703 tons against 7,875,130 tons in the United Kingdom; of manufactured iron, including rails, 2,820,377 tons were produced in America against 1,923,221 tons in Great Britain, and, of Bessemer steel, 3.688,871 tons were American produce, while the production in the United Kingdom amounted to 2,014,843 tons.

[1] 1891 appears to have witnessed a very remarkable falling off in the production of Bessemer steel, to the extent indeed of about 35 per cent., while the production of open-hearth steel exhibits a reduction in the past year of only 3 per cent.

Care seems to have been taken to render all conditions attending the trials as uniform as practicable, with this not unimportant difference, that very much less time was allowed to elapse, in the second and third trials, between the firing of the successive rounds than in the first experiments.

A careful consideration of the results led the Board, of which Admiral Kimberley was President, to the unanimous conclusion that the high carbon Harveyised nickel-steel plate was the best, but that one part of the plate was much superior in resisting powers to the other, which was ascribable apparently to a want of uniformity in the Harveyising or carbonising treatment. The official report is also said to have recorded the unanimous opinion of the Board that both the high carbon nickel-steel Harveyised plate and the high carbon nickel-steel untreated plate were superior to the Creusot nickel-steel plate tried in 1890.

Further trials will shortly be made of high and low carbon nickel-steel Harveyised plates, to be supplied by Carnegie, Phipps, and Co. From published analyses it appears that the high carbon nickel-steel plate manufactured by that Company contained 0·45 per cent. of carbon and 0·65 per cent. of manganese, and the low carbon plates of nickel-steel, 0·26 per cent. of carbon and 0·75 per cent. of manganese.

The *New York Sun*, with what appears, from the reported results, to be very justifiable sentiments of pride, winds up an account of the results arrived at with the remark that they show that America now stands at the top in the excellence of her ship-armour; and certainly our friends of the Bethlehem and Pittsburg Steel-works are to be warmly congratulated upon their achievements in this new direction.

Although the trials in the United States seemed to establish a marked superiority of nickel-steel plates over the compound plates of J. Brown and Co.'s manufacture, it is interesting to notice that this eminent firm is gallantly striving to maintain the high position which exhaustive trials had secured to that form of plate, as efficient armouring for ships of war, and that recent trials at Shoeburyness and at Portsmouth of experimental compound plates which have been submitted to a supplemental process devised by Captain Tressider, late Royal Engineers, seem, so far as I can learn, to have demonstrated that powers of resistance and endurance, much exceeding those of the compound plates tried in the United States and in the Ochta experiments of last year, can be secured to these structures. I have reason to hope that we shall receive a communication ere long on the interesting results which are being obtained in this direction.

My reference to the rapid advance which has been made in the United States in the manufacture of armour plates will recall to the minds of many here present the memorable visit of the Institute to America in 1890. The valuable record of that visit presented to us a few months ago by the American Institute of Mining Engineers, in the form of a portly volume, embracing full accounts of the proceedings and the papers read and discussed at the international meetings at New York and Pittsburgh, constitutes an important work of reference, as well as an interesting memento of one of the most notable events in the history of our Institute. And now, thanks mainly to the self-sacrificing exertions of our much-esteemed past President, Sir Lowthian Bell, we have been able to match this American volume with a companion work, the interest and value of which it would, I venture to say, be difficult to over-estimate. The series of monographs by Sir Lowthian Bell and other highly competent authorities which are embraced in this special volume (aptly named "The Iron and Steel Institute in America"), will certainly receive careful study—productive both of profit and of pleasure, at the hands not only of members of the Institute, but also of our transatlantic friends who so cordially received us; and our warmest thanks are due to the joint authors of this work, and especially to Sir Lowthian Bell, who, besides contributing some of the most valuable of its contents, undertook the arduous task of editing the volume; and I beg leave heartily to congratulate him upon the realization of his wish, that the completed work should make its first appearance in public at this meeting.

An interesting illustration afforded by the inaugural address of the Duke of Devonshire in 1869 of the advance made in the knowledge at the disposal of the iron and steel maker, is found in his observations on the relations of carbon to iron and steel, a subject which I had occasion to discuss in some detail in my opening address last year, in reference to the then recent interesting investigations in that direction; a subject on which we may still hope to have further light thrown by the continued researches of Osmond and others. The very complete and systematic manner in which existing knowledge on this subject is treated in the first part, recently published, of Dr. Hermann Wedding's new edition of his *Handbuch der Eisenhüttenkunde*, calls for the highest commendation.

The importance of pursuing the investigation of problems such as the conditions most favourable to economy in the use of fuel in the blast furnace, and conditions to be fulfilled in the form and dimensions of the furnace for ensuring efficiency and economy of working, were dwelt upon by the Duke of Devonshire in his comprehensive address, and reference was made to the elaborate inquiry into the chemical operations occurring in the blast furnace upon which Sir Lowthian Bell had then for some time been engaged. The interesting results arrived at by him, and the instructive discussions to which they and the conclusions based upon them gave rise, are memorable illustrations of the progress in the application of scientific research and reasoning to the study of metallurgic operations, in the promotion of which the Iron and Steel Institute has of late years played an important part, and the most recent outcome of which, in connection with the production of pig iron, is to be found in the remarkable achievements recounted by Mr. Gayley in his paper on the development of American blast furnaces, which was one of the most noteworthy communications dealt with at the New York meeting in 1890.

In directing attention to that paper in my address a year ago, I spoke of the reference made by Mr Gayley to the importance of the elaborate series of investigations carried out, nearly a quarter of a century ago, by Sir Lowthian Bell on the chemistry of the blast furnace. I have had occasion since then to refresh my memory with regard to the ground covered by the work which our ex-President then carried out, and I must freely confess that I had no recollection of its extent nor of the mass of interesting and important experimental data accumulated by him, until I lately referred to the comprehensive and systematic investigations on the chemical phenomena of iron-smelting, which he communicated in detail to the meeting of the Institute at Merthyr in 1870. His paper on the chemistry of the blast furnace, to which I had the pleasure of listening at the Chemical Society in 1869, deals with the circumstances and conditions attending the union of iron with carbon in the blast furnace, and gives interesting results bearing upon the question of the temperature at which carbon is deposited in a finely-divided state in ironstone when it is exposed to the waste gases, rich in carbonic oxide, of the blast furnace; and the subject is discussed more definitely, by the light of additional experimental information, in Sir Lowthian Bell's admirable work on the "Principles of the Manufacture of Iron and Steel," published in 1884. He there demonstrates the readiness with which carbon is desposited in iron sponge from carbonic oxide at temperatures up to a dull red heat, examines into the question whether the presence of iron in the metallic state in iron ore is indispensable for determining the dissociation of carbonic oxide, and, after concluding in the negative, and demonstrating that metallic iron is not more active in this respect than its oxide, he refers to trials made by him of the power of several other metals and metallic oxides to effect the dissociation of carbonic oxide.

In the researches communicated in 1870 to the Merthyr meeting, the whole of these experiments are given and discussed, and it is to be regretted that the interesting results arrived at did not receive greater publicity than they met with in the Transactions of a young technical Institute, then comparatively unknown in the scientific world, and in which the results of original scientific research would scarcely be sought for.

Without venturing to enter into the details of these researches, I may mention that experimental evidence favoured the conclusion that the carbon-impregnation of an iron ore by dissociation of carbonic oxide takes place at as low a temperature as de-oxidation, which, in the case of Cleveland ore, occurs at 200° to 210° C. (392° to 410° F.), and that freshly reduced spongy iron, at about that temperature, reduces carbon from carbonic oxide to an extent corresponding to 20–24 per cent. of its weight, but that, as the temperature approaches a red heat, the deposition of carbon diminishes considerably in amount.

The results of many experiments with other metals and their oxides showed that zinc, tin, chromium, and silicon, and their oxides are neither reduced by carbonic oxide at a temperature of about 420° (that of melted zinc), nor give rise to deposition of carbon; that copper and lead are reduced at temperatures up to a red heat, without deposition of carbon; that the higher manganese oxides are reduced to protoxide below a red heat without impregnation by carbon; but that nickel, and in a smaller degree cobalt, suffer reduction from their oxides, with deposition of carbon.

Sir Lowthian Bell, while conducting his experiments at temperatures considerably below those prevailing at the particular positions in the blast furnace where the production of pig iron was believed to be effected, did not have recourse to so low a temperature as that at which Messrs. Mond, Langer, and Quincke, after having demonstrated (what appeared, in the absence of an acquaintance with Bell's results, a novel observation) that carbon was separated from carbonic oxide by passing the gas over nickel at a high temperature, found that this metal actually entered into the composition of the gas. Thus they started from the point, in this particular direction, up to which Sir Lowthian Bell had carried his observations twenty years previously, and obtained the remarkable nickel-carbon-oxide compound referred to by me in my address last year, which they have since succeeded in producing upon so considerable a scale as to afford prospect of its acquiring industrial importance.

In the description of their earliest results, they stated that attempts to produce similar combinations of carbon oxide with other metals, including iron, had failed. By persevering with research in many very varied directions, and especially with iron, they at length succeeded in volatilizing notable, although small, quantities of the latter metal in a current of carbonic oxide, by using the finely-divided pure iron obtained by reducing the oxalate in a current of hydrogen at the lowest possible temperature (about 400° C.), by allowing the product to cool in hydrogen to 80°, and then by passing a current of carbonic oxide over the spongy metal. The gas, after this treatment, was found to impart a yellow colour to a colourless flame, and if conducted through glass tubes heated to between 200° and 350° C., it deposited a metallic mirror; at a higher temperature it furnished black flakes, which analysis showed to contain 79·30 per cent. of carbon. The quantity of iron- and carbon-oxide compound produced in this way was very small; by passing 2½ litres of carbonic oxide per hour over the metal (the latter being from time to time reheated in a current of hydrogen), the issuing gas contained not more than 0·01 grm. of iron, equal to less than 2 c.c. of the gaseous iron-compound in a litre of the carbonic oxide.

The gas-mixture, when passed through benzine or heavy mineral- or tar-oils, was partially deprived of the iron compound, and the result of examination of solutions of this kind led to the conclusion that the gaseous iron combination, analogous in composition to the nickel-carbon-oxide compound (or nickel-tetra-carbonyl), had been found, and that its formula was $Fe(CO)_4$.

In continuing their researches, Mr. Mond and Dr. Langer have succeeded in obtaining the iron compound in the form of a liquid of spec. grav. 1·4664 (at 18° C.), which distils without decomposition at 102°·8 C., and solidifies below 21° into yellow needle-shaped crystals. It is slowly decomposed by exposure to air, and when its vapour is heated to 180°, it is completely decomposed into iron and carbonic oxide. Analysis and the determination of its vapour density show the composition of the liquid to be represented by the formula $Fe(CO)_5$, and Messrs. Mond and Langer have therefore called the compound *ferro-penta-carbonyl.*

If exposed to light in a sealed vessel for several hours, it deposits gold-coloured tabular crystals having a metallic lustre like gold when dry, but becoming brown by gradual decomposition when exposed to air. These crystals appear to contain a slightly smaller amount of carbonic oxide than the liquid compound from which they are deposited. Mr. Mond and his co-laborateurs are still actively engaged in pursuing the researches which have brought to light the formation of these remarkable metallic compounds, whose discovery and properties suggest possibilities in several directions of technical chemistry which will doubtless lead to interesting investigations.

The first report made by Prof. Roberts-Austen to the Alloys Research Committee of the Institution of Mechanical Engineers, bearing upon the particular investigation undertaken by him at their request, although little more than introductory in its character, is full of interest, and of importance not only on account of the valuable information it furnishes regarding the method of investigation adopted by him and of the preliminary results attained by its agency, but also because of the interesting discussion elicited by its presentation to the Institution of Mechanical Engineers at their meeting last autumn.

At our annual gathering a year ago we had the advantage of receiving from Prof. Roberts-Austen a description of the autographic method adopted by him for recording the results indicated by the Le Chatelier pyrometer, the efficient operation of which I had an opportunity of witnessing as a member of the Alloys Research Committee. We also heard from Sir Lowthian Bell that he had already successfully and very usefully applied this pyrometer to determine the temperature of the blast entering a furnace at a considerable distance from the point of observation. We shall, I trust, have the advantage of learning the results of further experience by Sir Lowthian and others in the practical application of this much-needed instrument in conjunction with the automatic recording system used by Prof. Roberts-Austen; the observations made by the present President of the Institution of Mechanical Engineers, by Mr. Henry M. Howe, of Boston, and by others at the discussion of the Professor's report, demonstrated that several valuable applications were already being made of the Le Chatelier pyrometer and the system of continuous record of its indications. While it is satisfactory to me, as one of the earliest to use the ingenious pyrometer designed by my distinguished friend the late Sir William Siemens, to note that its trustworthiness as an indicator of temperatures up to 500° C. has been vindicated by the work of Messrs. Callendar and Smith, the accuracy and sharpness of the indications of Le Chatelier's pyrometer, the simplicity of its character, and the well established trustworthiness of its results at temperatures of over 1000° C., render it decidedly more valuable to the practical metallurgist, as well as to the scientific investigator, than any instrument of the class hitherto available. We shall none the less be glad to hear what Mr. Callendar has to tell us on the present occasion with regard to the results of his persevering and, I believe, successful labours in discovering and eliminating the defects of construction which served to destroy the confidence placed, in the first instance, on the indications afforded by platinum pyrometers.

The tendency of the discussion following the reading of Prof. Roberts Austen's report, which was shared in by Mr. Robert Hadfield, Mr. Henry M. Howe, and by some others whose right to criticism was beyond dispute, was to emphasise the necessity for caution in the application of theoretical views, regarding the laws which regulate the mechanical or physical properties of metals, to predictions as to the influence upon the properties of metals, such as iron, of particular impurities. I believe no one will be disposed to differ from the view expressed on that occasion by Prof. Arnold, that, for a thoroughly comprehensive examination into "the effects of small admixtures of certain elements on the mechanical and physical properties of iron, copper, lead, and other metals," it is indispensable to combine different lines of investigation with the particular one which Prof. Roberts Austen has so far prosecuted with very promising results.

The fame which Mr. Gruson has acquired in connection with the production of chilled iron structures, for land defence, presenting marvellous powers of resistance, must cause members of the Institute to look forward with much interest to the communication which has been promised us by the director of the Gruson Works, Mr. E. Reimers, on the manufacture and application of chilled cast iron, a subject with which, especially in regard to the selection of varieties and mixtures of iron suitable for securing a structure of metal essential to the attainment of combined toughness and hardness in armour-piercing projectiles, I was much concerned in the days of my much-lamented friend, the late Sir William Pallisser.

Another subject to which I devoted considerable attention twenty-three years ago, in co-operation with the late Dr. Matthiessen, bears directly upon some very interesting results which will be brought to your notice by my old and valued friend Colonel Dyer, of the Elswick Ordnance Works. In 1863 Dr. Matthiessen communicated to the British Association the results of some interesting researches into the chemical nature of alloys, which he followed up in 1866 with a preliminary report on the chemical nature of cast iron. In this memoir, after drawing a comparison between the physical deportment of what he terms the alloys of carbon and iron, and those of such alloys as are produced by copper with zinc and with tin, he discusses in some detail the question whether carbon exists in combination with iron, in cast iron, and expresses himself in favour of the view that white iron is not actually a chemical combination of carbon with the metal, but rather a solidified solution in it of carbon, while grey iron is a solidified solution of the same kind, with carbon mechanically intermixed. But while he supports this hypothesis by certain analogies between the specific electric conducting power of different varieties of iron and of alloys of other metals, he proposes to test the validity of his views by preparing pure iron, alloying it with various proportions of carbon, examining the physical and chemical properties of these alloys, and afterwards investigating the properties of alloys of the pure metal with various other metals and non-metals. Matthiessen's persevering endeavours to elaborate a process for the preparation of pure iron, which extended over three years, were at length crowned with success, and in 1869 I was engaged with him upon experiments with metal, obtained in the form of sponge, containing as its only impurity a minute trace of sulphur. This iron was prepared by fusing together perfectly pure and dried ferrous sulphate and sodium sulphate, completely washing the crystalline oxide thus obtained, and then reducing it to metallic sponge by heating it in thoroughly purified hydrogen. The sponge metal was welded together in the cold by powerful compression, for certain experiments; for others it was fused in very carefully prepared lime-crucibles. The experiments which it was hoped to undertake with this pure material, in the directions I have indicated, were arrested almost at their commencement by Dr. Matthiessen's death, and by the all-engrossing nature of my official labours. The process, which was elaborated with such trouble, may perhaps prove useful in connection with the investigation which Prof. Roberts-Austen has undertaken for the Alloys Research Committee of the Institution of Mechanical Engineers; but it appears to me that there is good prospect of procuring iron sufficiently pure, at any rate for certain of the experiments (when carried out upon a practical scale) which will form part of these investigations, by the very simple mode of procedure which Colonel Dyer has adopted in the production of iron containing only traces of carbon and silicon, no phosphorus, and less than two-hundreths of one per cent. of sulphur, and which affords a very interesting instance of the application of the basic furnace.

In concluding these few observations, I cannot forbear once more referring to the interesting address delivered to the members by our first President twenty-three years ago, in order to point out how strikingly its peroration illustrates the progress which has been made in the development of the steel industry during the past twenty-two years. While forcibly dwelling upon "the extraordinary influence which the manufacture of iron had come to exercise on the condition of society throughout the civilized world," the writer gives no indication of the part then played, or destined to be played, by *steel* in that civilizing influence. Even seven years later, when steel-manufacture had advanced with rapid strides, there was still great hesitation in adopting it for some of the most important purposes to which iron was applied; thus Sir Nathanial Barnaby wrote at that time, "Our distrust of steel is so great that the material may be said to be altogether unused by private shipbuilders." Yet, a few years afterwards, it had come to pass that the examples of the marvellous development in the applications of iron, to which the Duke referred in illustration of his statements, constituted the very directions in which the steel manufacturer has accomplished his most prominent achievements, and in which the use of iron is becoming a memory of the past.

The following was the list of papers to be read:—On experiments with basic steel, by W. H. White, C.B., F.R.S., Director of Naval Construction; on the production of pure iron in the basic furnace, by Colonel H. S. Dyer, of Elswick; on experiments on the elimination of sulphur from iron, by E. J. Ball, Ph.D., and A. Wingham, F.I.C.; on platinum pyrometers, by H. L. Callendar; on the manufacture and application of chilled cast iron (Gruson's system), by E. Reimers, of Magdeburg; on valves for open hearth furnaces, by J. W. Wailes; on the calorific efficiency of the puddling furnace, by Major Cubillo, of Trubia Arsenal, Spain; on a practical slide rule for use in the calculation of blast furnace charges, by A. Wingham, F.I.C.; notes on fuel, and its efficiency in metallurgic operations, by B. H. Thwaite.

The whole of these papers were read except that by Major Cubillo.

Mr. White's was the first contribution taken. His paper was founded on a number of experiments made at Pembroke Dockyard, with a view to determine the suitability of steel made by the basic process for ship-building purposes. It would be useless to attempt to summarise the results of the large amount of information contained in the paper, and in the tables, which formed an appendix to it. As a general fact, it may be said that basic steel no longer labours under the disadvantages that attended its early days, when it was undoubtedly unfit to be used as a ship-building material. The importance of the basic process to this country can hardly be overrated. The manufacture of steel on the original acid process demands a pig low in phosphorus, and this can only be prepared from a special ore, such as the hematites of Cumberland and other parts. Unfortunately, the deposits of such ore in the British Isles are very limited in extent, and it is for this reason that we have been, for years past, importing vast quantities of steel-making ore from the neighbourhood of Bilboa in Spain. This means a heavy item for freight; and it is a question whether we could, in England, stand the competition of Spain, if that country once organized her steel-making resources on a sound footing. But in any case it is desirable we should depend, as little as possible, on foreign countries for raw material, when we have such vast stocks within our own borders. In the ores of the Cleveland district and other parts, we have such deposits, but the ore contains a comparatively large percentage of phosphorus, which entirely unfits it for the old acid process of steel-making. The basic process, however, is designed to enable phosphoric pig to be used, and to judge by Mr. White's paper a fair measure of success has been attained in this direction. It would have been interesting if the paper had given details as to the pig from which the steel was made. Mr. Martell has said that no steel to meet Lloyd's requirements has been made from pig containing 3 per cent. of phosphorus, and that the basic steel which has been successful has been made from an ore low in phosphorus. It is, however, not the bulk of the phosphorus which is difficult to eliminate, but the last part, and Sir Lowthian Bell stated that he would be glad if the pig of his district did contain 3 per cent. of phosphorus instead of about half that quantity, as it would then produce a slag more valuable for fertilizing purposes. However this may be, it would have been satisfactory to have had full analyses of pig to attach to particulars of physical tests so well authenticated as those now given to the engineering world by Mr. White's paper. Another point upon which it is desirable to get information is, which process gives the best results in working on the basic principle? We have always considered it a settled matter that the open-hearth furnace was superior to the converter in this respect, so far as the quality of the product is concerned, and the discussion of last Thursday, on the whole, tended to confirm this opinion. The opposite view, however, was advanced by more than one speaker whose words should carry weight; and there is also the question of cost and quickness of production to consider. On the whole, it would seem, therefore, that the problem as to whether the converter or the open-hearth furnace should be used is still an open one; doubtless it will be settled in this case, as before, by the special requirements of the metal to be produced. As we have said, we cannot reproduce even a brief abstract of Mr. White's paper, but we can give one or two figures. One sample of basic Bessemer had a tensile strength of 30·6 tons per square inch, and an extension in 8 inches of 26 per cent. Of some pieces tested after annealing the tensile strength was about 28 tons, with an elongation of 25 per cent. One sample of basic open-hearth showed 31·3 tons per square inch tensile strength and 26·2 per cent. extension in 8 inches. We quote these figures as showing the best results, and to serve as a guide; it is doubtless unnecessary to say that they are not conclusive standing alone. The riveting tests given are valuable, but these are of a nature which cannot be epitomized.

Colonel Dyer's paper might well have been longer, as the subject of it is one of considerable importance. Pure iron is a substance at any rate difficult to get. Sir Lowthian Bell has said he has never met with absolutely pure iron. Commercially pure iron, or what might be called practically pure iron, is not uncommon. Colonel Dyer's object was to obtain a pure iron in order to determine the value of alloys. By working on the lines which he had followed, the author hoped that pure iron and steel may be produced at reasonable cost. In the first experiments the furnace was charged in the ordinary manner with pig and scrap of fairly good quality, and the charge was worked slowly, care being taken to keep the slag well saturated with lime by liberal additions of limestone. The phosphorus was reduced during the process, but the result left much to be desired in other respects. Charges composed of from one-half to four-fifths of good scrap, and one-half to one-fifth of good Swedish pig were then worked very quickly, and a remarkably pure iron was obtained, of which the following was the result of analysis:—

Combined carbon	trace
Silicon	·005
Manganese	trace
Phosphorus	trace
Sulphur	·015

This iron could only be forged in small pieces, even with the greatest care, and therefore no results could be given as to its mechanical properties. Dr. Hopkinson had determined the magnetic properties of the metal, but the results are to be reserved for the Royal Society. Speaking generally, it has been found that the metal is more easily magnetized for small magnetizing forces than any other metal hitherto tested; its coercive force is less, its magnetization is greater, than any other sample experimented with. The next stage of Colonel Dyer's experiments had for their object the utilization of ordinary scrap steel, and the production, in the basic furnace, of steel high in carbon and low in phosphorus, and at the same time to decrease the wear and tear of the furnace. The principle of the process consists in melting scrap with carbonaceous material, and the results of the experiments have shown that when a pure carbonaceous material and ferro-manganese free from phosphorus can be obtained there will be no difficulty in producing a pure carbide of iron containing only sufficient manganese for forging. The author next described the method by which the process was carried out. Nine consecutive charges were worked, with the object of producing steel containing varying percentages of carbon, to test the value of the process. The following table gives the chemical analyses and the mechanical properties of the steel of these charges:—

Tensile Tests.					Chemical Analysis.				
No.	Yield.	Break.	Elongation.	Fracture.	C.C	Si.	Mn.	P.	S.
			Per cent.						
1	14·0	22·7	44·0	F.	·11	trace	·21	trace	·030
2	14·0	23·0	41·5	F.	·10	,,	·21	,,	·030
3	18·0	27·5	32·0	F.	·16	·020	·40	·018	·022
4	21·0	30·0	33·0	F.	·21	trace	·39	·014	·026
5	20·0	31·2	32·5	F.	·25	·014	·43	trace	·019
6	23·0	34·0	26·0	F.	·24	·018	·50	·019	·024
7	25·0	35·4	20·0	F.	·30	trace	·38	·019	·017
8	25·0	43·2	18·5	F.	·53	·012	·54	·016	·028
9	24·0	45·3	14·5	F.G.	·50	·031	·60	·009	·026

The paper by Messrs. Ball and Wingham, on the elimination of sulphur, contained the results of experiments thoughtful and suggestive in themselves, even if they do not show the iron and steel maker any immediate results which he may apply. The authors found that potassium cyanide placed on the surface of molten cast iron almost completely removed the sulphur. Owing to the extreme volatility of the cyanide, it was not found possible to reduce the quantity required to within practical limits, and efforts were therefore made to find some flux which would retain, when molten, a quantity of cyanide sufficient to effect the desulphurisation. Sodium carbonate, lime, and blast-furnace slag were in turn tried. It was found that the desulphurising action was greater when the flux consisted mainly of sodium carbonate than when a less basic lime slag was used; and that in the latter case the diminution in the percentage of sulphur varied directly with the amount of added cyanide. A table is given of the results of the experiments, the best condition being obtained when 200 grains of sodium carbonate and 100 grains of potassium cyanide were used to 2000 grains of metal, when the sulphur was reduced from 0·46 per cent. to 0·06 per cent. A further experiment with sodium carbonate alone—400 grains being added to 4000 grains of metal—the sulphur was reduced from 1·11 to 0·15 per cent. With caustic soda the sulphur was reduced from 0·15 per cent. to 0·02 per cent., which is a satisfactory result. The experiments also showed the facility with which sulphur is reduced when present in large quantities, and that it is the last part which gives difficulty in removing. Metallic sodium was introduced into the bath in the form of an alloy with lead, and this had the effect of entirely removing 0·18 per cent. of sulphur.

The paper by Mr. Reimers, which was the first read on Friday, the second day of the meeting, does not call for notice, excepting, perhaps, to remark that the Council of the Institute were to blame for not taking care that the author was informed beforehand that his contribution was not of a nature which should have been submitted in the form in which it was read. Mr. Callendar's paper on "Platinum Pyrometers" is a great contrast to the last-mentioned. The prominence given to the Le Chatelier pyrometer in this country, by Prof. Roberts-Austen chiefly, has led to renewed hope on the part of those who desire to measure higher temperatures. Mr. Callendar has been amongst those who have been giving attention to the subject, and the results of his labours, which are distinctly valuable, are given in his paper, to which we would refer all practically interested in the matter. His introductory remarks on air pyrometers are interesting, and may be read with advantage by those not already acquainted with this branch of the subject; but it is of the Siemens electrical resistance thermometer, known generally as the "platinum pyrometer," that he has most to say. It has been hitherto accepted that the platinum pyrometer was subject to the serious defect of changing its zero with use. The British Association Committee of 1874 discovered this, and it has since been amply confirmed as a fact. The Committee experimented chiefly with a pyrometer in an ordinary fire at moderate temperatures of about 800° C., and they found that the resistance increased continuously with heating, and that the wire underwent rapid deterioration. They also made some experiments and suggestions with a view to remedy this defect, but they did not succeed in overcoming it. This continuous change of zero is certainly the most serious practical defect that a pyrometer can have, and there can be no doubt that the report of the British Association did a great deal to destroy confidence in this method of measuring temperature.

We cannot do better than continue Mr. Callendar's communication on this part of the subject in his own words:—

"About seven years ago, when I began making experiments on this subject at the Cavendish Laboratory, Cambridge, I was at first very much surprised to find that the platinum wires which I used did *not* undergo continuous change, even when subjected to much more severe tests than those applied to the Siemens pyrometer by the Committee of the British Association. By making further experiments, however, with a sort of imitation Siemens pyrometer, I succeeded in reproducing at pleasure the effects they had observed, and in proving to my own satisfaction that these defects were not inherent to the method, but merely incidental to the particular form of instrument on which they experimented. I found that if the wire were properly protected from strain and from contamination, the pyrometers could be made practically free from change of zero, even at very high temperatures.

"The construction of the Siemens pyrometer has not, so far as I am aware, undergone any material change since 1874. The coil of platinum wire, which forms the sensitive part of the instrument, is wound on a clay cylinder, and packed in an iron tube from 5 to 8 feet long, and about an inch or so in diameter. I have here the fine wire and the clay cylinder from a pyrometer which was recently in use at the Royal Arsenal, Woolwich. I was informed that it had never been heated above 900° C., or 1600° F., but its resistance had increased some 15 per cent., corresponding to an error of about 100° F. in the temperature measurements. When the instrument was taken to pieces it was found that the wire was quite rotten and brittle in some places, and sticking to the clay cylinder. This, I think, is sufficient evidence that the clay, or some impurity contained in it, attacks the wire, otherwise the local nature of the action could not be explained, unless the quality of the wire used was very inferior.

"I have tried several materials on which to wind the wire, but have found nothing that answers so well as mica. The plan I generally adopt is to double the wire on itself, and wind it round a very thin plate of mica, in such a way that it only touches the mica at the edges. This method gives very good insulation, even at high temperatures, and, so far as I can discover, the mica has no action on the wire even at temperatures of 1200° C.

"Another defect of the Siemens pyrometer is the iron-containing tube. Metallic vapours of any kind will attack the wire readily, and will ruin the pyrometer. It is not probable that the iron itself will be appreciably volatile at temperatures below 1000° C., but it is very likely to contain several more volatile impurities. Vapours of copper, tin, zinc, &c., rapidly render the wire brittle and useless. A comparatively small trace suffices."

Mr. Callendar's wires were inclosed in glass, a material which naturally cannot be used for high temperatures. He finds that a hard-glazed porcelain tube does very well to protect the wire, at least up to temperatures of 1200° C. A silica tube would be better, but that the author has not succeeded in obtaining. He pointed out, however, that good porcelain is not so fragile as it is generally thought to be. He has only broken one tube, and that with a hammer. He hopes, however, ultimately to be able to produce a satisfactory silica tube. The remainder of the paper was taken up with a description of the indicating apparatus, but here, again, we must refer our readers to the original paper.

Mr. Thwaites's paper is of far too formidable proportions for us to deal with in anything like detail in this notice. He describes calorimeters, pyrometers, &c., and their uses. A good deal of the matter put forward is not altogether new.

Mr. Wingham's paper on the slide rule is of value to those interested in the practical working of blast furnaces.

Mr. Wailes's gas furnace valve has been designed to give an absolutely air-tight closing, an effect which is obtained by a water seal. Illustrations were given by means of wall diagrams.

The meeting was brought to a close with the usual votes of thanks.

The autumn meeting will be held in Liverpool, but the date is not yet fixed.

THE YEARLY ADMISSIONS TO THE ROYAL SOCIETY.[1]

The discussions that arose in connection with the revision of the Statutes of the Royal Society during the years 1890 and 1891, led me to endeavour to obtain definite data on which to found a trustworthy opinion as to the effect of the existing limitation of the number of yearly admissions on the eventual total strength of the Society, and the probable result of increasing the number beyond fifteen, the present limit.

The facts bearing on this subject, so far as I have been able to collect them from the records of the Society, are embodied in the tables annexed to this communication, for the proper appreciation of the significance of the figures in which a few preliminary explanations are necessary.

The anniversary of the Society being fixed for November 30 in each year, the customary record of the number of Fellows for any year refers to the number on that date. I have throughout regarded the date to which this number applies as being January 1 of the following year.

The annual election of Ordinary Fellows usually takes place in the first or second week of June in each year. I have considered the date to be January 1 of the same year.

The lapses, whether from death or other causes, have been treated as having occurred at the end of the calendar year in which they take place.

These assumptions have been made to simplify the various computations that the investigation required (which have been sufficiently troublesome as it is), and owing to the considerable period dealt with, forty-three years, the results will not, I believe, be sensibly affected thereby.

Unless it is otherwise specifically stated, the numbers refer exclusively to the *Ordinary Fellows*, elected at the regular annual meetings fixed for the purpose.

So far as I have been able to ascertain (for the earlier records in many particulars are defective), the number of Ordinary Fellows elected since 1848 has been 15 in each year, except on four occasions; in two years the number having been 14, and in two years 16: the average, therefore, is 15 yearly.

During the period since 1848, the number of *Royal* and *Honorary* Fellows has been about 5, and the *Foreign* Members about 50; these are included in the total number of Fellows shown in the annual reports of the Council, but will not be further considered in what follows.

The rules under which certain privileged classes have been admitted as Fellows, in addition to the *Ordinary* Fellows, have varied somewhat since 1848, but at present, apart from the persons eligible for the classes of Fellows above excluded, the only persons so privileged are Privy Councillors. The total number of *Privileged* Fellows elected since 1848 seems to have been 75, which for 43 years gives an average of 1·75 per annum.

Table I. contains a summary of the available data relating to the total number of Fellows since 1848.

The total number, excluding Royal, Honorary, and Foreign Fellows, at the commencement of 1848 was 768. I am not able to say how many of these were Fellows elected in the ordinary way, and how many were privileged, but this has no importance for my present object. From 1860 onwards the distinction between the three classes, those elected before 1848, Privileged Fellows, and Ordinary Fellows, is exhibited.

At the end of 1890, the total number of Fellows, excluding the Royal, Honorary, and Foreign Classes, was 463; of whom 26 were Fellows elected before 1848, 36 were Privileged Fellows elected since 1848; and 401 Ordinary Fellows elected since 1848.

Hence it appears that the reduction of number of Fellows, of the three classes last referred to, has been 305, and as the number of admissions of the Privileged class has not been very materially affected by the changes in the rules relating to them, it follows that virtually the whole of this large reduction is a consequence of the restriction, to 15, of the number of Ordinary Fellows elected yearly.

As the ages of the 768 Fellows who constituted the bulk of the Society in 1848 are not known, and as the conditions of election before that year differed materially from what they have been since, no very useful conclusions can be drawn from the rate of their diminution since 1848.

Assuming, however, that the number of Privileged Fellows in 1848 was, as is probable, about 50, there would remain 718 Ordinary Fellows, of whom in 43 years 692 lapsed, or at an average yearly rate of 2·24 per cent., that is rather more than 16 a year. This rate, as I shall show subsequently, does not differ greatly from that which has prevailed among the Ordinary Fellows elected since 1848, and it may therefore be presumed that the average age of the Fellows in that year did not differ greatly from the average age since.

Table II. gives, as far as available data admit, the ages at the time of election of all Fellows elected since 1848; and shows the number of years they severally survived, the average age at election, the number and average age of those who were alive in 1891, and the greatest and least ages of Fellows elected in each year.

From this table it will be seen that there has been a gradual small increase in the age at election; the average for the first 10 years having been 42·2; for the second 10 years, 43·0; for the third 10 years, 44·8; and for the last 13 years, 45·2.

The accuracy of these conclusions may be somewhat affected by the greater number of unknown ages in the earlier years, the age when unknown having been taken at the average of the group of years in which the election took place.

The least age at which any Fellow has been elected is 24, one such case being recorded. The average minimum at any election is slightly under 30, and the average maximum is rather over 63; one election at an age of 87 is recorded, and several above 70.

The oldest survivor of the Fellows elected since 1848, who alone are dealt with in this table, was 86 years of age in 1891.

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[1] "On the Probable Effect of the Limitation of the Number of Ordinary Fellows elected into the Royal Society to Fifteen in each Year on the eventual Total Number of Fellows." By Lieut.-General R. Strachey, R.E., F.R.S. Read at the Royal Society on May 12, 1892. This paper was accompanied by four tables, presenting summaries of the author's results.

The average age at election was 43·9, and the average age of all the Fellows in 1891 was 58·4.

Table III. records the numbers of Ordinary Fellows elected in each year, and remaining alive in each year after election, until 1891.

From this it will be seen that during the last ten years the numbers have increased by 46; in the previous ten years the increase was 68, or 22 more; and in the ten years still earlier the increase was 111, or 43 more than the last. If the decrease of growth for the ten years after 1890 takes place in a similar ratio to that which took place between 1870–80 and 1880–90, we might anticipate an increase of only 11 up to 1900, or probably a smaller number.

In order to obtain a satisfactory comparison between the lives of the Fellows, and those of the general population as shown in the accepted life tables, I have calculated, from the known ages of the Fellows at election, and the known dates of the deaths that have occurred among them, the average age of the Fellows remaining alive in each year. From these ages I have computed, from Dr. Farr's tables, the probable number of Fellows that would survive from year to year, assuming the initial number to be 15.

From Table III., above referred to, has been ascertained the number of Fellows surviving in each successive year after election, and thence has been obtained the average number surviving from an initial number 15.

The results of these computations will be found in Table IV.

The second column in this table shows the number of lives dealt with for each year after election. The first entry, 645, is the total number of Fellows elected in the whole 43 years. The next column to the right gives their aggregate ages, and the next their average age, 44·9, in their first year. Following the same line to the right, we find the average number of Fellows elected, and in their first year.

Passing to the second line of the table, 619, immediately below 645, is the total number of Fellows remaining in their second year from the elections of 42 years; this is succeeded, in the columns to the right, by their aggregate ages in their second year and their average age, and the average number in their second year, out of 15, the average number elected.

The third line gives the same data for the third year of Fellowship, and so on throughout, the last line but one showing that in their 42nd year there remained 6 Fellows from the elections of 2 years, with an aggregate age of 444 years, and an average age of 74·0, the average number surviving in their 42nd year, out of the 15 elected, being 3.

The sixth column of the table gives the successive sums of the numbers in the fifth column, and therefore indicates the aggregate number of Fellows that will, on the average, be surviving in each successive year of Fellowship, the number elected in each year being always supposed to be 15.

It will be seen that the total for the 43rd year is 397·0, whereas the actual number surviving, shown in column XI., is 401. This difference is of course due to the number 397 representing what the result would be if the average rates of election and decrease prevailed, instead of the actual rates for the separate years; and it is probably sufficiently accounted for by the fact, already pointed out, of the gradually increasing age at election in the later years, which will lead to the lives in the earlier years of the series being somewhat better than the average. Column XI. shows the *actual* results for successive years corresponding to the average results given in column VI. The differences will be seen to be somewhat irregular, but nowhere to be of importance.

Column VII. gives the aggregate ages of the numbers surviving in successive years, as shown in column V., and from it is deduced the average age of the whole number of Fellows shown in column VI., 397, which is seen to be 57·7 years, a result differing slightly from that obtained from the actual ages of the Fellows surviving in 1891, which was shown to be 58·4. The cause of this difference has already been indicated.

Columns VIII. and IX. supply the results that would be obtained by applying to an initial number of 15, the rates of mortality in Dr. Farr's tables, for the ages in successive years given in column IV. Column X. contains the ratio of column VI. to column IX., and indicates that throughout the whole period of 43 years the actual results are somewhat better than the tabular results, or that the lives of the Fellows are better than the ordinary lives, and that this advantage leads in the 43rd year to the actual number of survivors being rather more than 5 per cent. in excess of that which would be given by the life tables, or of about 20 on a total of 400.

An examination of this table will show that, with the exception of the last six or eight years, in which the number of lives dealt with at last becomes very small, the figures indicate a very regular and consistent progression, and it will practically be quite safe to assume that the series in column VI. may be extended on the basis of the ordinary life tables, subject to the addition of 5 per cent. on the total amounts obtained from these last.

Hence it will be found that in 10 years after 1891 the aggregate number of Fellows is not at all likely to be increased by more than 15, that the final result may be as little as 410, but is not likely to be more than 420, or at the outside 425.

In an earlier part of this paper, I mentioned that the rate of decrease of the Ordinary Fellows elected before 1848 did not appear to differ materially from that which has prevailed subsequently.

Taking the number of Ordinary Fellows elected before 1848, and then alive, at 718, it will be found that in 12 years (1860) the number was reduced to 422, which is about 60 per cent. of the original number; after 24 years (1872) the number fell to 206, which is about 30 per cent. of the original; and in 36 years (1884) there remained only 65, which is about 9 per cent. of the first number.

Assuming that the average age of the 718 Fellows elected before 1848, and then alive, was not materially different from (58) the average age of the Fellows elected after 1848 and alive in 1891, when it has probably become nearly stationary, it may be inferred that the lapses among a body of Fellows of that age will correspond to the lapses among the Fellows alive in 1848. Now, from Table IV. it will be seen that of the Fellows elected after 1848, the average age in their 17th year was 58·3 years, which is almost exactly the average age of the whole body. Further, it is shown that of the supposed original 15 there remained 10·9 in the 17th year of the age above mentioned, 58·3. This number was reduced in 12 years to 6·7, which is nearly 60 per cent. of the number in the 17th year, and again falls after 12 years more to 3·7, which is not very different from 30 per cent. of the starting number, and after 12 years more the number will be seen to be likely to be less than 1·0, which again will not differ materially from 9 per cent. of the original 10·9. These proportions, it will have been observed, are those above shown to hold in the case of the Fellows elected before 1848.

On the whole, it seems to be established that the present restriction to 15 of the number of Ordinary Fellows elected in any year will lead to an eventual maximum number not exceeding 420; and that the ultimate increase of the total strength of the Society, for each additional Fellow elected in excess of 15 may be taken at 28, so that an increase to 18 of the annual number of Ordinary Fellows elected would lead to an ultimate total of 500 such Fellows.

THE ERUPTIONS OF VULCANO (AUGUST 3, 1888, *TO MARCH* 22, 1890).[1]

THERE are some 180 (nominally 212) pages and 11 plates. Of these latter 4 are reproductions of Silvestri's beautiful whole-plate photographs [one of Vulcano at rest (with Vulcanello), and the other three instantaneous views of the volcano in eruption]. A fifth reproduces, half-size, two of Dr. Johnston-Lavis's instantaneous views of eruptions taken from the crater's edge.[2] Two other plates give 14 excellent photographs of the "bombs," and of the rest two are sketches of Stromboli crater, one petrographical, and the last the map of Vulcano (1/50,000).

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[1] "Le Eruzione dell' Isola di Vulcano, incominciate il 3 agosto, 1888, e terminate il 22 Marzo, 1890: Relazione scientifica della Commissione incaricata degli studi dal R. Governo," *Annali dell' Ufficio Centrale di Meteorologica e Geodinamica*, Parte 4, vol. x., 1888 (Rome, 1891).

The Commission was originally as follows:—President, Prof. O. Silvestri (Catania), Prof. G. Mercalli (Milan), Prof. Grablovitz (Seismological Observatory, Ischia), and as engineer, V. Clerici (Messina), with A. Cerati, Prof. Ponte, and A. Silvestri, as assistants.

As is known, Prof. Silvestri died before the publication of the Report, but not till some months after the end of the eruptions, on which he had elsewhere published various papers. The Commission must thus have had full time to profit by his experience both in the field and afterwards, and his name appears as author or joint author of a number of sections. After Silvestri's death, Prof. Mercalli, the largest contributor to this Report, took his place, and brought the work to its completion.

[2] For others by Dr. Lavis and Silvestri, see "South Italian Volcanoes."

A table of contents may be found at the end.

Appended to the various sections are the names of the authors responsible. The 180 pages of text necessarily vary in character. Thus, 50 pages are devoted to an almost daily record of the state of the volcano during the twenty months of the eruption. For not a few days we have a record of the times and degree of violence of all the explosions which (February 12 and 14, 1889) might number more than 100 between 10 a.m. and 6 p.m. On the other hand, we find between pp. 207 and 210, a *résumé* of the chief facts observed, and the conclusions to which they point.

There are 20 pages (9–29) on the topography and geology of the island of Vulcano. Details are given as to the rocks collected at various localities, and the conclusion (expressed with some reserve) as to the history of the island, is very similar to the view stated (Proc. Geol. Assoc., vol. xi. pp. 395-96, 1890) by Dr. Johnston-Lavis.

The author (Mercalli) only recognizes one crater (with lavas of andesitic and basaltic type) in the "Piano" district, which forms the southern half of the island. The Serro di Capo and Monte Lentia represent the western part of a second old (north-west) crater of more "acid" type, which may have had its centre almost coincident with that of the present active cone, and which, judging by the weathering of the rocks, may be older than the Piano crater. The author notices that the straight north and south line, drawn from *Vulcanello* through the *hot springs* by the "Faraglioni" and the two overlapping "*Forgia Vecchia*"-*s* (on the north flank of Vulcano) to the present crater (or "*Fossa di Vulcano*"), if continued, strikes *Monte Saraceno* (a lateral cone on the north-west edge of the Piano crater). It is then pointed out that, assuming Monte Saraceno to be situated over a continuation of the crack which most probably runs from Vulcano to Vulcanello, and assuming the present eruptive centre to coincide with that of the old north-west crater, that then the present "Fossa di Vulcano" is situated on the point of meeting of two cracks, viz. a north to south one from Vulcanello to Monte Saraceno, and a north-west to south-east one joining the more ancient craters. The present crater would then be situated over a weak point. Whether or no Monte Saraceno be situated over a crack extending south from Vulcano rather than over some other, there is nothing at any rate in the above against the view expressed in Prof. Judd's "Volcanoes" (see Fig. 81), according to which there is one main crack beneath the island of Vulcano, the crack from Vulcano to Vulcanello being but a continuation of that on which the more ancient craters lie. As to the number of craters more ancient than the main modern cone, it will be seen that the Report takes a view intermediate between that of Scrope ["Volcanos," 2nd edit., p. 192, Fig. 47] and that of Judd ["Volcanoes," p. 196, and Figs. 77 and 85].

The twenty pages (30–50) devoted to the records of previous eruptions are naturally full of interest. A number of quotations from older writers are given. The conclusion is that the eruptions of Vulcano in the historic period have been on the whole very similar.

As interesting dates may be noticed:—475 B.C., Vulcano in activity (Thucydides); 183 B.C., Vulcanello formed; about 1550 A.D., strait between Vulcanello and Vulcano filled up by eruption of the latter; 1727, Forgia Vecchia (on north slope of Vulcano) in eruption (D'Orville); 1771, "Pietre Cotte" obsidian stream (on north flank of Vulcano) poured out; 1878, Fumaroles still visible on Vulcanello.[1]

From p. 53 to p. 174 is devoted to (1) detailed record of the eruptions, as to which a valuable *résumé* is given, pp. 112–14; (2) seismological and various other physical observations; and (3) the description of the erupted products.

The following epitome is based on that given by Silvestri, pp. 207–208:—

(*a*) The recent activity of Vulcano lasted 20 months, viz. August 3, 1888, to March 22, 1890 (with final explosions, May 17), the most violent explosions (p. 113) occurring on August 4, 1888, December 26, 1889, and March 15, 1890. There had previously been a period of repose (1832–72), followed by minor premonitory eruptions in 1873–7–8–9 and 1886.

(*b*) Just as we have the "*Plinian*" or "*Vesuvian*" eruptions of Vesuvius accompanied by violent outbursts of "ashes" and welling out of lava, and the incessant, milder "*Strombolian*" type of eruption, so we may distinguish a "*Vulcanian*" type (pp. 58–59). Characteristic of this are—

(i.) Intermittent explosions with discharge of bombs, ash, dust, and vapours. Each of these explosions resembles the first outburst of "Plinian" ("Vesuvian") eruptions (p. 112).
(ii.) The absence of lava streams.
(iii.) The absence of noteworthy earthquake shocks.

(*c*) The more violent of the explosions burst out suddenly, discharging clouds of vapour, with dust lapilli, and more or fewer bombs and fragments of compact lava, and such an explosion was then followed at short intervals by feebler ones, which merely discharged the smaller materials, or vapours only.

(*d*) The more violent explosions were generally separated by longish intervals, either of absolute repose, or with insignificant explosions; and, on the other hand, when eruptions took place every few minutes, they were generally feeble.

(*e*) (p. 113, 70) Observations of atmospheric pressure extending over a day, or short period of time, show no relation to the frequency or degree of violence of the explosions. But viewing the 20 months of the eruption as a whole, it is found that Vulcano enjoyed comparative repose during periods of high atmospheric pressure, or of small change, and was most active during periods of change from fair to stormy weather, with marked fall of barometer.

(*f*) Though during the 20 months of the eruption there were altogether a good many earthquakes recorded either by the seismoscope, or by some of the inhabitants (pp. 134–37), still these were but slight, and, as stated, formed no feature of the eruption, being very rare compared with the explosions.

It was found (pp. 125–28) that for making observations of the shocks or tremors accompanying the explosive eruptions, even close to the foot of Vulcano, seismoscopes were as a rule not sensitive enough. On the other hand, owing to the frequency of the explosions, a tromometer was never quiet. The simplest method is often the best, and recourse was had to pools of mercury (at once sensitive and stable). With the aid of a reflector it was then easy to keep an eye at once on the reflection of some object in the mercury, and on the lip of the crater, and so observe the time relation between the tremors and the explosive outbursts.

Observations made near the base of Vulcano showed that each eruption was preceded by a short tremor (apparently the result of a deep-seated explosion), followed after a short interval of calm, of from a few seconds to three-quarters of a minute, by another, the result, apparently, of the superficial explosion that made a vent for the vaporous and solid ejecta. The interval was shorter in the case of the more violent explosions.

(*g*) In the first three days of the eruption (pp. 54 and 152–58), August 3–5, 1888, the ejecta consisted mainly of a variety of old materials blocking the neck of the volcano. These, much of which was more or less altered by solfataric action, were discharged in pieces of all sizes from fine dust to large masses.[1]

(*h*) After an interval of thirteen days, the second main period of the eruption set in. The older materials soon became almost entirely replaced by newly elaborated matter in the form of dust, lapilli, lighter or heavier "bread-crust" bombs,[2] and masses of compacter lava. These, as opposed to the matter discharged during the first three days, were all, except for inclusions of older rocks, of essentially similar mineralogical and chemical constitution (of andesitic type (p. 165), with 62–67 per cent. of silica, the percentage of which might be greater in the centre than in the crust of the same bomb). The larger masses on leaving the crater had a high initial temperature, and were plastic, taking rounded, elongated, or flattened forms, and on reaching the ground melted various metallic wires—silver (1000° C.), and copper (perhaps 1200°, but, as we are cautioned, the copper might oxidize and then fuse lower).

From the preceding, Silvestri draws the following conclusions:—

(Excluding the ejecta of the first three days) The high temperature and plasticity, with the presence of inclusions of older rocks, and the uniform composition of the ejecta, point to their being derived from a molten magma of recent elaboration. Of this, all things considered, there was probably a vast reservoir at a depth probably far below the bottom of the adjacent sea (which is 670 metres on the east, and 500 metres on the west). At intervals the steam included in this molten lava would acquire sufficient force to burst forth, producing the premonitory tremor (see (*f*) above, and pp. 125–28); and though it is not very clearly stated, I gather that the interval of calm between the first and second tremors is considered to have been occupied by the escape of such steam into the space between the surface of the deep-seated lava and the crater floor, till it acquired sufficient pressure to force an exit through the mouth of the crater (which became plugged by the fall of ejecta after each eruption). Then the visible explosion would take place, accompanied by the second tremor.

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[1] Dr. Lavis found these practically extinct in 1887 (see NATURE, vol. xxxviii. p. 13).

[1] The Report describes these as not so hot as the later ejecta. However, from Mr. Narlian's graphic account (*Times*, September 13, 1888, and Brit. Assoc. Report, 1888, p. 665) it would seem that, at the first outburst, some of the ejecta fell red-hot, so as to set hedges, &c., on fire.

[2] Dr. Lavis, in NATURE, vol. xxxix. p. 110.

The "bread-crust" bombs (with pumiceous interior and cracked subvitreous crust) are said to commonly contain inclusions of older rock, and it is suggested (pp. 163 and 209) that the frothing up of the interior is *in part* due to these, for, says he, fragments of rock falling into a superhydrated molten lava may not improbably act as centres of ebullition, just as solids (in proportion to their extent of surface) cause rapid disengagement of gas when dropped into "soda"—or other aërated—waters.

The compact fragments and masses sometimes ejected (pp. 120, 160, and 209), notably in the last eruption, might be explained as pieces of the shells of domelike bubbles which had partly consolidated below the volcano, or as derived from less hydrated parts of the magma.

If there was this huge lake of lava and so much steam, why did not the lava appear at the surface? Silvestri points out that the rise of the lava will depend on the proportion of the compressed steam to the mass of the lava that contains it, and on the resistance offered to its escape. If the exit of the steam is blocked by lava, we may have all the phenomena of a "Plinian" ("Vesuvian") eruption. On the other hand, in 1888 Etna had eruptions of vapours only, and we get all stages between these two. In the case of a large space partly filled with lava at a great depth below the surface, the conditions might well be such that the steam would escape long before the lava overflowed.

Among other points dealt with in the Report may be noticed:—Pp. 143–45, the breaking three times during this eruptive period of the submarine cable between Lipari and Milazzo in Sicily. The first and third breaks were near the same spot, and near a place where the sea was seen to "boil," with pumice rising to the surface.

On p. 147 observations are recorded which support the view that the electric discharges accompanying eruptions depend principally on the friction of much dust and fine ejecta. Violent explosions discharging large masses, if unaccompanied by such finer matter, might be without the electric phenomena (p. 146).

There are ten pages on the state of Stromboli during the eruption of Vulcano, from which there appears to have been no relation between the two. Nor do the "secondary phenomena" (the hot springs and fumaroles) in these islands appear to have been markedly affected. Some of the fumaroles increased and some decreased in vigour, and some showed no change.

From what has been said as to the slight seismic effects, we are prepared to hear that no change in the level of the land was produced. In this connection there is a chapter on the tides, which have an amplitude at Lipari of about 30 cm.

On p. 120 are given four sections, in three, of the crater of Vulcano before, during, and after the eruption, from which it is seen that the crater has been much filled up.

On November 18, 1891, the writer found the crater still in the quiet solfatara condition, so that one could descend into it. The higher slopes were covered with white, and the lower, where the fumaroles were more marked, with yellow and red crystalline deposits. A little water lay at the bottom. The deepest part was a funnel-like depression, a little to the north of the middle, somewhat as shown in Mercalli's figure for April 1890. This marked the last eruptive vent.

In conclusion, then, the Report contains a great mass of facts, and in addition generalization and theory, which, as often based on long experience, are also welcome; and the Commission is to be congratulated.

G. W. BUTLER.

SOCIETIES AND ACADEMIES.

LONDON.

Anthropological Institute, May 10.—Dr. Edward B. Tylor, F.R.S., President, in the chair.—The election of the Duke of Devonshire and Dr. H. Colley March was announced.—Mrs. Bishop (Miss Isabella Bird) read a paper on the Ainos of Japan, amongst whom she had spent some time in a village near Volcano Bay. It is doubtful whether the Ainos were the aboriginal inhabitants of Japan; they say themselves that they conquered and exterminated an earlier race who dwelt in caves. The men are strongly built and muscular, and their stature varies from about 5 feet 4 inches to 5 feet 6 inches. The extreme hairiness ascribed to the Ainos applies only to the mountain tribes, and to the men only amongst them; the women, and the men of the coast tribes, not being more hairy than many people of other races. The houses are rectangular and built of wood; they are all constructed on the same plan, and have a large window at the east end opposite the door, and two smaller ones in the south side, below which is the shelf on which the boys of the family sleep; the girls occupy a similar shelf on the north side of the room, and during the night the sleeping-places are screened off by mats. The women are remarkable for their modesty, and the men are exceedingly gentle, obliging, and hospitable. They are a religious people, and offer copious libations of "saki" on the slightest provocation. The race is dying out, and will no doubt be quite extinct in the course of a few generations.

PARIS.

Academy of Sciences, May 24.—M. d'Abbadie in the chair.—Heats of combustion and formation of alcohol and of formic and acetic acids, by MM. Berthelot and Matignon.

$$\mathrm{C_2(diamond) + H_6 + O = C_2H_6O}\left\{\begin{array}{lr} & \text{Cal.}\\ \text{liquid} \ldots & +\,69{\cdot}9\\ \text{gas} \quad \ldots & +\,59{\cdot}8\\ \text{solution} & +\,72{\cdot}4\end{array}\right.$$

Heat of combustion of liquid alcohol at constant pressure = 324·5 cal.

$$\mathrm{C\ (diamond) + H_2 + O_2 = CH_2O_2}\left\{\begin{array}{lr} & \text{Cal.}\\ \text{solid} \quad \ldots & +\,103{\cdot}3\\ \text{liquid} \quad \ldots & +\,100{\cdot}8\\ \text{gas at } 200^\circ & +\,90{\cdot}0\end{array}\right.$$

Heat of combustion of liquid formic acid at constant pressure = 62·5 cal.

$$\mathrm{C_2(diamond) + H_4 + O_2 = C_2H_4O_2}\left\{\begin{array}{lr} & \text{Cal.}\\ \text{solid} \quad \ldots & +\,119{\cdot}7\\ \text{liquid} \quad \ldots & +\,117{\cdot}2\\ \text{gas at } 250^\circ & +\,107{\cdot}1\end{array}\right.$$

Heat of combustion of liquid acetic acid at constant pressure = 209·4 cal.—Some facts in the chemical history of nickel, by M. P. Schützenberger.—Degradation products of the tissues, particularly of the muscles, separated from the living being: analytical methods, by MM. Armand Gautier and L. Landi.—On the *Bramus*, a new type of fossil rodent from the Quaternary phosphorites of Berberah, by M. A. Pomel.—On the flexure of Gambey's mural circle, by M. Périgaud.—On the appearance of Saturn's ring at the present time, by M. G. Bigourdan. On May 21 M. Bigourdan made some observations of Saturn's ring, with special reference to its thickness. He noted several uneven portions at different points, thus confirming the observations of previous workers.—On integrals in dynamics, by M. P. Painlevé.—On equations in dynamics, by M. R. Liouville.—Approximate equation to the trajectory of a projectile in air when the resistance is supposed to be proportional to the fourth power of the velocity, by M. de Sparre.—Experimental researches on the *matériel de la batellerie*, by M. F. B. de Mas.—On the characteristic equation of various vapours, by M. Ch. Antoine.—The two phases of the persistence of luminous impressions, by M. Aug. Charpentier.—Plastic sulphur formed from sulphur vapour, by M. Jules Gal.—Some basic nitrates, by MM. G. Rousseau and G. Tite.—On the preparation and properties of arsenic cyanide, by M. E. Guenez.—Occurrence of fluorine in modern and fossil bones, by M. Ad. Carnot.—Apocinchonine and diapocinchonine, by MM. E. Jungfleisch and E. Léger.—Monosodium pyrocatechol, by M. de Forcrand.—Substitution reactions in carbon or nitrogen nuclei: application to explosive compounds, by M. C. Matignon.—On dibromomalonic acid, by M. G. Massol. The heats of neutralization by each successive KOH are about 10 cal. superior to those of malonic acid. The general conclusion is drawn that the substitution of H by a haloid increases the thermal value of the acid function.—Alcohols superior to vinyl alcohol, by M. C. Bardy.—Action of esters of unsaturated acids on ethyl sodium cyanacetate, by M. P. Th. Muller.—On a tetramethyl-meta-diamidobenzidine, by M. Charles Lauth.—On the embryology of a Proneomenia, by M. G. Pruvot.—Researches on the general cavity and excretory apparatus of Cirrhipedes, by M. Kœhler.—Anatomical study of the secondary wood of certain apetalons, by M. C. Houlbert.—On the relations of the Trias in the south-east Paris basin, by M. A. de Grossouvre.—Variations in the mean temperature of the air in the region of Paris, by M. E. Renou.—On a natural ice-cave at Creux-Percé (Gold Coast), by M. E. A. Martel.

Berlin.

Meteorological Society, May 3.—Prof. von Bezold, President, in the chair.—Dr. Schwalbe gave an account of observations on the extent and spread of anomalies of temperature in Germany based on synoptic weather-charts. He showed that the weather-types introduced by Teisserenc de Bort hold good for Germany, especially in winter, and that, as a result of the varying distribution of barometric pressure, they are the cause of very marked differences of temperature between the north and south, the east and west. These types are less frequently observed in summer, although both then and in the spring certain very marked distributions of pressure exist.—Prof. Spörer spoke on the recent magnetic storm of April 25, for which, as also for the great storms of February 13 and 14, he had been unable to discover any corresponding phenomena in the sun-spots at the same dates.

DIARY OF SOCIETIES.

London.

THURSDAY, June 2.

Royal Society, at 4.—Election of Fellows.——At 4.30.—On the Method of Examination of Photographic Objectives at the Kew Observatory: Major Darwin.—Supplementary Report on Explorations of Erect Trees containing Animal Remains in the Coal Formation of Nova Scotia: Sir J. W. Dawson, F.R.S.—The Hippocampus: Dr. A. Hill.—On a New Form of Air-Leyden, with Application to the Measurement of Small Electrostatic Capacities: Lord Kelvin, P.R.S.—On Certain Ternary Alloys; Part VI., Alloys containing Aluminium, together with Lead (or Bismuth) and Tin (or Silver): Dr. Wright, F.R.S.—The Conditions of the Formation and Decomposition of Nitrous Acid: V. H. Veley.—On the Theory of Electrodynamics as affected by the Nature of the Mechanical Stresses in Excited Dielectrics: Dr. J. Larmor.—On Current Curves: Major Hippisley.

Linnean Society, at 8.—On the Disappearance of Desert Plants in Egypt: E. A. Floyer.—On Insect Colours: F. H. Perry Coste.—Lantern Demonstration.

Chemical Society, at 8.—Ethylene Derivatives of Diazo-Amido Compounds: R. Meldola, F.R.S., and F. W. Streatfield.

Royal Institution, at 3.—Faust: R. G. Moulton.

FRIDAY, June 3.

Geologists' Association, at 8.

Royal Institution, at 9.—Metallic Carbonyls: Ludwig Mond, F.R.S.

SATURDAY, June 4.

Royal Institution, at 3.—Some Modern Discoveries in Agricultural and Forest Botany; Prof. H. Marshall Ward, F.R.S.

TUESDAY, June 7.

Royal Institution, at 3.—Some Aspects of Greek Poetry: Prof. R. C. Jebb, M.P.

WEDNESDAY, June 8.

Geological Society, at 8.—The Tertiary Microzoic Formations of Trinidad: R. J. Lechmere Guppy. (Communicated by Dr. H. Woodward, F.R.S.)—The Bagshot Beds of Bagshot Heath (a Rejoinder): Rev. A. Irving.—Notes on the Geology of the Nile Valley: Johnson Pasha and H. D. Richmond. (Communicated by A. Norman Tate.)

THURSDAY, June 9.

Mathematical Society, at 8.—On the Reflection and Refraction of Light from a Magnetized Transparent Medium: A. B. Basset, F.R.S.

Royal Institution, at 3.—Faust: R. G. Moulton.

FRIDAY, June 10.

Physical Society, at 5.—Some Points connected with the Electromotive Force of Secondary Batteries: Dr. J. H. Gladstone and Mr. Hibbert.—Workshop Ballistic and other Shielded Galvanometers: Prof. W. E. Ayrton and Mr. Mather.

Royal Astronomical Society, at 8.

Royal Institution, at 9.—Magnetic Properties of Liquid Oxygen: Prof. Dewar, F.R.S.

SATURDAY, June 11.

Royal Botanic Society, at 3.45.

Royal Institution, at 3.—Some Modern Discoveries in Agricultural and Forest Botany: Prof. H. Marshall Ward, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Theoretical Mechanics: J. Spencer (Percival).—The First Part of Goethe's Faust, carefully revised, with Introduction by C. A. Buchheim (Bell).—Influenza, 2nd edition: Dr. J. Althaus (Longmans).—The Physiology of the Invertebrata: Dr. A. B. Griffiths (L. Reeve).—Annual Report of the Smithsonian Institution to July 1890 (Washington).—Lessons in Elementary Mechanics, new edition: Sir P. Magnus (Longmans).—Elements of Physics: C. E. Fessenden (Macmillan and Co.).—An Elementary Course in Theory of Equations: C. H. Chapman (Gay and Bird).—A Text-book in Retaining Walls and Masonry Dams: M. Merriman (Gay and Bird).—A Treatise on the Mathematical Theory of Elasticity, vol. i.: A. E. H. Love (Cambridge University Press).—Der Peloponnes, Abteilung ii.: Dr. A. Philippson (Berlin, Friedländer).—Topographische und Hypsometrische Karte des Peloponnes: Dr. A. Philippson (Berlin, Friedländer).—The System of Mineralogy of J. D. Dana, 1837–68; Descriptive Mineralogy, 6th edition: E. S. Dana (Kegan Paul).—Die Tägliche Gang der Temperatur und des Sonnenscheins auf dem Sonnblickgipfel: Dr. W. Trabert (Wien, Tempsky).—Bacteriologisches Practicum: Dr. W. Migula (Karlsruhe, O. Nemnich).—In Starry Realms: Sir R. S. Ball (Isbister).—A Hand-book of the Management of Animals in Captivity in Lower Bengal, Ram Bramha Sányál (Calcutta).—Mineralogy: Dr. F. H. Hatch (Whittaker).—Darwin and after Darwin; I. The Darwinian Theory: Dr. G. J. Romanes (Longmans).—Animal Coloration: F. E. Beddard (Sonnenschein).—The Discovery of America, 2 vols.: J. Fiske (Macmillan and Co.).—A Text-book of Geometrical Deductions: J. Blaikie and W. Thomson (Longmans).—Distinction and the Criticism of Beliefs: A. Sidgwick (Longmans).—Solutions of the Examples in a Treatise on Elementary Dynamics: S. L. Loney (Cambridge University Press).—Theoretical Mechanics, Division I.: J. C. Horobin (Bell).—A Hand-book of Practical Astronomy; W. W. Campbell (Ann Arbor, Michigan, *Register* Publishing Company).—Logarithmic and other Mathematical Tables, 2nd edition: W. J. Hussey (Ann Arbor, Michigan, *Register* Publishing Company).—The Universal Atlas, Part 15 (Cassell).—Life in Motion: Prof. J. G. McKendrick (Black).—An Elementary Text-book of Magnetism and Electricity: R. W. Stewart (Clive).—The Two Spheres of Truth: T. E. S. T. (Unwin).—The Essentials of Histology, 3rd edition: Prof. E. A. Schäfer (Longmans).—Planisphere for Latitudes 68° to 48°, and Key to Planets until 1901: M. W. Harrington (Ann Arbor, Michigan, *Register* Publishing Company).—The Optical Indicatrix and the Transmission of Light in Crystals: L. Fletcher (Frowde).—Tasmanian Official Record, 1892 (Hobart).

Pamphlet.—The Rutherfurd Photographic Measures of the Group of the Pleiades: H. Jacoby (New York).

Serials.—Bulletin of the New York Mathematical Society, vol. i. No. 8 (New York).—Bulletin de la Société Impériale des Naturalistes de Moscou, No. 4 (Moscou).—Zeitschrift für Wissenschaftliche Zoologie, liii. Band, Supplement (Williams and Norgate).—Natural Science, June (Macmillan and Co.).—Annalen des k.k. Naturhistorischen Hofmuseums, Band vii. Nr. 1 u. 2 (Wien, Hölder).—Proceedings of the Royal Physical Society, Session 1890–91 (Edinburgh).—Internationales Archiv für Ethnographie, Band v. Heft 2 (Leiden, Trap).

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THURSDAY, JUNE 9, 1892.

A PROFESSORIAL UNIVERSITY OF LONDON.

THE recent history of the London University question affords decisive proof that the new University, which is to be the outcome of the labours of the Royal Commission now sitting, must be much more than a merely exclusive or merely local institution. Of the two main objects of a University in any English sense of the expression—the promotion of the higher education, and the advancement of learning—both must be equally subserved; and neither will be attained if the new University be established on other than the broadest possible basis, or if its development be controlled and hindered by rivalries that could not but become of an ignoble character. In the course of discussion it has been made abundantly clear that a duplication of Universities in London would be a misfortune of the first magnitude, dividing resources and diverting energies into channels that would lead to many undesirable results. It is equally clear that a University, consisting of a federation of local educational institutions existing within the same narrow area, would be wanting both in unity and force: its government would tend to become a succession of compromises effected between the interests, almost wholly of a financial nature, of its constituent Colleges. It may, then, be taken as a conclusion accepted by the great majority of those who have given special attention to the subject that there should be one University, and one only, in London, and that it should not be of a federal character. To this position it is a simple corollary that the government of the proposed University should be vested mainly in a professorial body. Much the most important work of the University would be the enactment of curricula and syllabuses and the control of teaching and examination—work that can only be efficiently performed by those specially familiar with the subjects taught. With the Professors a proper number of Crown nominees should be associated to act as moderators and as representatives of general educational policy, as well as to guard the interests and assure the continued confidence of the public. With the mode of creation and with the functions of the usual Faculties, and with the details of examinational systems, we need not at present concern ourselves. In fact, the less the new University is fettered by any Charter or Act the better, and it would be a misfortune were the precedent followed of the complicated and minutely detailed Charter recently rejected by the Convocation of the London University. On that occasion, it must be admitted, Convocation made good use of its veto, but its continued possession of such a power would, we think, be a source of disquiet and danger, without any corresponding advantage to Convocation itself, or the University—especially a professorial University—or indeed to the public. A much more useful provision would be the grant of a power of appeal to some such Committee of the Privy Council as that by whose aid the Scotch Universities are enabled to settle their differences.

The possibility of any such University as we have indicated above ever coming into existence—and for a University of any other kind it is scarcely worth while to exert oneself—depends largely on the good will of the existing Colleges. They must follow the capital example set by Bedford College, and signify their willingness to be merged in and become part of a true London University with such reservations in respect of particular portions of their collegiate work as may be necessary. As far as the professorial staffs of these Colleges are concerned, there can be little doubt but that they would hail such an event; but it is possible that the governing bodies may take a different view. And with regard to the Medical Schools, the reservations touching their purely professional work, must, from the nature of the case, be extensive.

Though, for the moment, the question of a new University is chiefly interesting from the point of view of science and medicine, what for the sake of brevity may be termed the arts aspect of the question must not be neglected. There are very few science students who do not follow—and follow of necessity—special courses of instruction in fairly equipped laboratories; but the arts student is less constrained in his mode and course of study—he has, indeed, in London less opportunity of benefiting by adequate instruction in the subjects of his studies. The stimulus to every form of education that the new University may be expected to give will supply this deficiency; but meanwhile, and probably to a greater or less extent always, the case of the "private student' in arts will have to be considered. We shall not enter upon it here. Our object in mentioning the case of the arts student is rather to show that the interests of the two great divisions of human knowledge are at one in the matter of the proposed University. It may be added that the "private student" difficulty, so far as it exists, should be left to be dealt with by the new University. It is limited in character, though extensive in scope, and is very far indeed from being insurmountable.

To resume. We are entirely in favour of a single non-exclusive London University, mainly, or at least adequately, of a professorial character—which by no means necessarily involves the extreme teacher-examiner system—controlling both teaching and examination, and being or becoming, by absorption or otherwise, homogeneous in interest, and in the highest degree authoritative in function. All these features are entirely novel; they are not, we believe, possessed by any British University. And herein lies the practical difficulty now to be confronted. The present opportunity for creating such a University is not likely to recur, at all events for some generations to come. What is to be done to make the best of it? The Royal Commission is fully aware of the greatness of the task committed to it, and has entered upon its labours in no niggard, narrow, or unappreciative spirit. But the Commission must be aided by educational opinion clearly thought out and firmly expressed. It must have the support of the London University, of the great Colleges, of the Medical Schools, and of the professorial body in London, who should be aided by the sympathy of their brethren in the provinces—a sympathy, there is good reason to believe, that will not be wanting. Such professorial opinion will include that of the staffs of the Colleges and Schools, and of those members at least of the Senate and Convocation of the University of London who are or have been engaged in professorial work. So powerful a body of opinion cannot but exert a great—indeed, a decisive—influence upon what may be termed the lay elements of the governing bodies, whom we can only reach through their professorial colleagues.

It is difficult to see how the arguments of eminent specialists in support of the general arguments called forth by the occasion can be rejected, when once the novelty of their proposals has been got over. Convocation, with an appeal to the Privy Council, will have a far more usable and useful power than is inherent in the bare obstructiveness or quasi-terrorism of the veto. The Senate in Burlington Gardens will scarcely refuse to complete the University character of the great institution it governs, and perfect its educational machinery, by placing the responsible direction of the higher education of all its students, without exception or distinction, in the hands of the most eminent representatives of those who have made such education the business of their lives. The Medical Schools will only give up the teaching they are least adapted to furnish, and in lieu of being scattered entities, will become integral portions of a great whole. The private arts student will retain every advantage and privilege he possesses, and cannot but gain by working under syllabuses prepared by past masters in the art of teaching.

Perhaps the best procedure to be adopted by the Professoriate, with whom the initiation of any active propaganda must lie, will be to lay their views before the governing bodies by deputation, and before the Commission by the individual testimony of such among them as may be invited to give evidence on the question. Here a word of caution may not be out of place. Details of a ministerial nature should be avoided as much as possible, for until the main lines of any scheme are settled, it is difficult to say what details are possible or necessary. It is still more important to shun any approach to doctrinairism, the besetting vice of professordom, and treat every principle as modifiable by the circumstances of history, national habit, and environment.

On the financial aspect of the question we can say little. The establishment of a new University will cost money, but no great sum will be needed to start with. The University will, of course, be independent, and the necessary expenses will be defrayed in part by an annual Government grant. Among other sources of income, the funds at the disposal of the County Council may perhaps be counted, and with a view to such assistance it might be found advisable that the University should have a commercial and technical, as well as a purely academical side.

But for the moment, what is of most importance is, we repeat, that the London Professoriate should organize itself, formulate its principles of action in the sense above indicated, and use its influence, publicly and privately, to procure their acceptance as far as circumstances may show to be possible.

INDIAN BOTANY.

Annals of the Royal Botanic Garden, Calcutta. Vol. III. (1) The Species of Pedicularis of the Indian Empire and its Frontiers, by D. Prain, M.B., F.R.S.E., Curator of the Herbarium. (2) The Magnoliaceæ of British India, by G. King, M.B., LL.D., F.R.S., C.I.E., Superintendent of the Garden. (3) The Genus Gomphostemma, by D. Prain. (4) The Species of Myristica of British. India, by G. King. 4to, pp. 350, tt. 174. (Calcutta: Printed at the Bengal Secretariat Press, 1891.)

THE two previous volumes of this publication are devoted entirely to the illustration and description of the arboreous element in the Indian Flora, and the letter-press is solely the work of Dr. King. Volume I. deals with the difficult genus *Ficus*, illustrated by 232 plates; and the second volume treats of the almost equally difficult genus *Quercus* and the allied *Castanopsis*, as well as the genus *Artocarpus*, of which seventeen species are described and figured. As may be seen from the list of papers given above, the work in the present volume is partly by Dr. King, and partly by his Curator, Dr. Prain; the former continuing his valuable labours on the trees of India, whilst Dr. Prain has taken up two herbaceous genera. A critical review of this ponderous volume would require more space than could be given to it in the pages of NATURE, and a much deeper knowledge of the subjects than the writer possesses; but it is not a difficult task to give an idea of the nature and quality of the series of monographs it contains. At the outset one is disposed to find fault with the bulk and fourteen pounds weight of this book, because it is really fatiguing to handle, and smaller volumes are in every way more desirable. Fortunately, the present volume may be conveniently bound in three nearly equal parts, as each monograph has its separate title-page and index. Indeed, it might be preferable to bind each of the four monographs separately.

The present volume, it will be perceived, is partly devoted to utilitarian botany, which will be welcome to the forestry department, as well as to botanists generally, and partly to botany of a kind that appeals more especially to the biologist. Dr. Prain's elaborate and painstaking monograph of the genus *Pedicularis* belongs to the latter category, and may be recommended for study to the young aspirant for honours in the same direction as a model of thoroughness, so far as external morphology goes. To persons acquainted only with our two native species of *Pedicularis*, the wide range of modification exhibited in the forms of the corolla is surprising, and reminds one of Prof. Huxley's remark that the genus *Gentiana*, as generally circumscribed, presents nearly as much variation in the shape of the corolla as all the genera of the Gentianaceæ combined. This polymorphism is sufficiently illustrated in the comparatively recent monograph of the whole genus *Pedicularis* by the late Mr. Maximowicz. He figures the flowers of all the species known to him, whilst Dr. Prain figures the plants, or portions of the plants, of all the Indian species, as well as their flowers. Great as is the variety, however, in the size and shape of the corolla in *Pedicularis*, it would be wrong to say that it is nearly as great as in the whole order of the Scrophularineæ. The two principal kinds of variation are the length and the relative diameter of the tubular portion, and the shape of the lips, especially of the upper one, of which there are many curious and even fantastic modifications. Maximowicz's monograph of the whole genus (which is dispersed all round the northern hemisphere, and perhaps extends just over the equator in the Andes) includes about 250 species, and a few have been discovered in India and China since. Prain's monograph of the Indian species contains nearly double the number described in the "Flora of British India" in 1884. The systematic part is preceded by an elaborate and masterly essay on the distribution and descent of the species, illustrated by diagrams and a map. The latter might certainly, with a little extra work, have been made clearer. Dr. Prain divides the genus primarily into three groups—namely, *Longirostres*, *Aduncæ*, and *Erostres*—based on the modifications of the upper lip of the corolla; and the names are sufficiently descriptive to indicate their application. Each of these groups contains both opposite (or verticillate) and alternate leaved species, and is subdivided into a number of sections. So far as we have tried the keys to the sections and species we have found them work admirably, and the descriptions are evidently very carefully written; but twelve to eighteen lines of description in the ablative absolute without a stop or any variation in type is bewildering, and an innovation that is to be deprecated. Dr. Prain himself appears to have realized this, for in his account of *Gomphostemma* his descriptions are shorter and punctuated, with the names of the various organs in italics.

Dr. King's monographs of the Magnoliaceæ and the genus *Myristica* are written entirely in English, perhaps with advantage, because Latin descriptions are not so easily understood as English by many persons interested in trees. Including the suborder Schizandreæ, the number of Indian Magnoliaceæ described and figured is forty-five, referred to eight genera.

Passing on to his monograph of the species of *Myristica* of British India, we find that he distinguishes sixty-eight, illustrated by sixty-nine plates. By British India, Dr. King understands political British India, including the Nicobar and Andaman Islands, and the territories of the Straits Settlements. Dr. King follows Bentham and Hooker, and others, in referring all the nutmegs to the one genus *Myristica*, and, as thus limited, it is represented in nearly all tropical countries. Ten years ago, less than a hundred species were described, but Dr. Warburg, who is at present at Kew engaged on a monograph of the order, estimates the number now in herbaria at about 200. This great augmentation is almost wholly from discoveries in the Malayan Peninsula and Archipelago, New Guinea, and Eastern Polynesia. Dr. King abstains from any attempt to trace the geographical distribution of the species, on the ground that he believes many yet remained to be discovered. But on running through his work we find that about fifty-four of his sixty-eight species are from the Malayan region, eight from the Deccan and Ceylon, and about six from the Assam and Chittagong region, only two apparently being found as far westward as Sikkim, in North India. Most of the new species are from Perak, a country exceedingly rich in endemic trees. Beyond the distribution indicated, there is one species in North Australia, and four each in Madagascar and Tropical Africa, and perhaps about forty or fifty in America, extending from South Brazil through the West Indies and Venezuela to Central America and South Mexico. The author is careful to explain that he does not regard the present effort as anything approaching finality, and anyone acquainted with the genus will understand the difficulties encountered in working from herbarium specimens alone. With one interesting exception (*Myristica canarioides*, King) the species are diœcious, and female flowers are much rarer than males; and the fruit, which affords good characters in a fresh condition, is often wanting, or not in a good state for description. But if Dr. King's work is necessarily incomplete, it supplies the very best materials for the foundation of a more exact knowledge. The figures, although possessing no great artistic merit, are faithful portraits of authentic specimens of the several species, and, combined with the very full descriptions, are sufficient to enable botanists to determine most of the species. On the other hand, the fine work in the analyses of the flowers is indistinctly reproduced in some of the plates, apparently in consequence of their having been drawn on too small a scale. The flowers, it may be added, of many species, are exceedingly small, of some not more than a twentieth of an inch in diameter. But I must draw this notice to a close with the remark that this volume is a monument to the skill and industry of Dr. King and his colleague, and a credit to the native lithographers and printers. One only marvels how the authors, with their multifarious duties, accomplish so much in a tropical climate.

W. BOTTING HEMSLEY.

MATHEMATICAL RECREATIONS AND PROBLEMS.

Mathematical Recreations and Problems of Past and Present Times. By W. W. Rouse Ball. (London: Macmillan and Co., 1892.)

THE idea of writing some such account as that before us must have been present to Mr. Ball's mind when he was collecting the material which he has so skilfully worked up into his "History of Mathematics." We think this because the extent of ground covered by these "Recreations" is commensurate with that of the "History," and many bits of ore which would not suit the earlier work find a fitting niche in this. Howsoever the case may be, we are sure that non-mathematical, as well as mathematical, readers will derive amusement, and, we venture to think, profit withal, from a perusal of it. The author forewarns possible readers that "the conclusions are of no practical use, and most of the results are not new." This is plain language, but, lest the warning should be too effectual, he adds, "At the same time I think I may assert that many of the questions—particularly those in the latter half of the book—are interesting, not a few are associated with the names of distinguished mathematicians, while hitherto several of the memoirs quoted have not been easily accessible to English readers." We have thus stated the author's *pros* and *cons*, and remark that he has gone very exhaustively over the ground, and has left us little opportunity of adding to or correcting what he has thus reproduced from his note-books.

There are two sources to which every writer on the subject of the earlier part must apply, viz. the "Problèmes plaisans et délectables," by C. G. Bachet, Sieur de Meziriac, and Ozanam's "Récréations mathématiques et physiques." These Mr. Ball carefully discusses as to editions and their respective merits.

The work before us is divided into two parts: mathematical recreations and mathematical problems and speculations. The former consists of seven chapters. In the first chapter are collected together numerous problems with numbers, watches, and cards. Some of these last are interesting to the mathematician, and have been discussed in the *Messenger of Mathematics* and the "Reprint from the *Educational Times*." The Middle Ages furnish some curious questions, and an antique problem in *decimation* is associated with the name of Josephus, but these are well-known instances. Bachet's weights problem calls for mention. It finds a place in the author's algebra; the omissions in Bachet's argument, Mr. Ball notes, have been supplied by Major MacMahon (see NATURE, vol. xlii. pp. 113, 114). Mersenne's numbers have been treated recently at some length by Mr. Ball in the *Messenger of Mathematics* (vol. xxi. pp. 34–40); in this account it is stated that $2^{61} - 1 = 2\,305\,843\,009\,213\,693\,951$ is the biggest known prime. Fermat claims some space (cf. NATURE, vol. xviii. pp. 104, 344). Of his so-called *last theorem* (no integral values of x, y, z, can be found to satisfy the equation $x^n + y^n = z^n$, if n is an integer greater than 2) we read:—

> "This proposition has acquired extraordinary celebrity from the fact that no general demonstration of it has been given, but there is no reason to doubt that it is true."

It is fitting that we should give Mr. Ball's grounds for this belief.

> "Fermat was a mathematician of quite the first rank who had made a special study of the theory of numbers. That subject is in itself one of peculiar interest and elegance, but its conclusions have little practical importance, and since his time it has been discussed by only a few mathematicians, while even of them not many have made it their chief study. This is the explanation of the fact that it took more than a century before some of the simpler results which Fermat had enunciated were proved, and thus it is not surprising that a proof of the theorem which he succeeded in establishing only towards the close of his life should involve great difficulties."

Proofs have been given in the cases of $n = 3, 4, 5, 7, 14$ (cf. pp. 28, 29). Many subjects of interest take up the second chapter, as "Geometrical Fallacies" (every triangle is equilateral, and the whole is equal to a part: this latter we think we have seen in an article by De Morgan); curious "Proofs by Dissection" (cf. *Messenger of Mathematics*, vol. vi. p. 87), there is a printer's error (p. 35, l. 9 up) of $\tan^{-1}\frac{1}{40}$ in place of $\tan^{-1}\frac{1}{46}$; "Colouring Maps" (only four colours necessary to colour a map of a country, divided into districts, in such a way that no two contiguous districts shall be of the same colour), the literature of this problem is brought fully up to date; an account is given of the results of Cayley's "Contour and Slope Lines," and of Clerk Maxwell's "Hills and Dales." Then follow "Statical Games of Position" ("Three in a Row" and "Tesselation," both problems connected with the name of Sylvester); "Dynamical Games of Position" ("Shunting," "Ferry-boat Problems," and numerous counter, pawn, and solitaire problems), and a glance at "Paradromic Rings."

Chapter iii. treats of "Some Mechanical Questions," as "Perpetual Motion," the "Underhand Cut on a Tennis Ball" (*Messenger of Mathematics*, vol. vii.), the "Boomerang," and the "Flight of Birds" (NATURE, 1890–91). In chapter iv. we have a miscellaneous lot, the fifteen puzzle, Chinese rings, the fifteen school-girls problem, and such card problems as Gergonne's pile problem, the mouse-trap, and many others. Chapter v. discusses "Magic Squares," and chapters vi. and vii. are devoted to "Unicursal Problems." These are Euler's problem (more fully discussed by Listing, "Topologie," and Tait), mazes, geometrical trees, the Hamiltonian game, and the knight's path on a chess-board. All these matters are treated lucidly, and with sufficient detail for the ordinary reader, and for others there is ample store of references. There is no chance of catching Mr. Ball tripping in his use of books, and his ready access to mathematical journals can hardly be surpassed, so that we have not come upon any new facts. We may mention, however, in connection with the knight's path, that there is a short article, accompanied by diagrams, on the subject in the *Leisure Hour* (December 20, 1873), by H. Meyer, of the *Hannoverische Anzeiger*.

The second part, in its opening chapter, gives at some length an account of the three classical proplems, viz. the duplication of the cube, the trisection of an angle, and the quadrature of the circle. Chapter ix., on astrology, has many curious details relating to that science, and gives a facsimile of Cardan's drawing of the horoscope of Edward VI., with an abstract of Cardan's account. On the whole matter of the chapter Mr. Ball writes:—

> "Though the practice of astrology was connected so often with impudent quackery, yet one ought not to forget that nearly every physician and man of science in mediæval Europe was an astrologer. These observers did not consider that its rules were definitely established, and they laboriously collected much of the astronomical evidence that was to crush their art. Thus, though there never was a time when astrology was not practised by knaves, there was a period of intellectual development when it was accepted honestly as a difficult but real science."

De Morgan, it may be remembered, in the "Budget" (p. 278) says:—

> "If anything ever had a fair trial, it was astrology. The idea itself is natural enough. A human being, set down on this earth, without any tradition, would probably suspect that the heavenly bodies had something to do with the guidance of affairs."

"Hyperspace," which occupies chapter x., has a full bibliography (compiled by G. B. Halsted, *American Journal of Mathematics*, vols. i. and ii.), forms the subject of one of Mr. Hinton's interesting "Scientific Romances" (cf. NATURE, vol. xxxi. p. 431), and is connected with Dr. Abbott's "Flatland" (NATURE, vol. xxxi. p. 76). Mr

Ball has made all these the text for a clear account of our present knowledge of higher space. The two last chapters rapidly survey "Time and its Measurement" and "The Constitution of Matter."

Our analysis shows how great an extent of ground is covered by the "Mathematical Recreations," and when we add that the account is fully pervaded by the attractive charm Mr. Ball knows so well how to infuse into what many persons would look upon as a dry subject, we have said all we can to commend it to our readers. The book is most carefully printed (only three or four typographical errors have met our eye, and the figures on pp. 32 and 33 the student will recognize must be drawn incorrectly).

SOILS AND MANURES.

Soils and Manures. By John M. H. Munro, D.Sc. (Lond.) (London: Cassell, 1892.)

THE preface to this book informs us that "it is written for the use of young people in schools and colleges, and those numerous other readers who take an intelligent interest in the how and why of familiar facts and operations, yet have no special training in the language and methods of science."

We must admit that Dr. Munro has succeeded in his endeavour to write a book so simple that it may be put into the hands of a beginner with confidence that he will find few difficulties unexplained, and so trustworthy that the more advanced student may find it helpful and suggestive.

We are having a flood of small agricultural books just now, consequent upon the great movement for technical education in England, but we believe that this book will reach two classes of readers which the majority of other text-books do not seem to have affected. These two classes of readers are farmers and teachers in elementary schools. Too many of these books are written with the idea of preparing students for examination, and they may serve their purpose, but are not very likely to help forward the cause of technical education in agriculture to any considerable extent.

Such education has lately been much talked about, and written about also, and men of authority and experience have even gone so far as to say that the recent attempts to promote it have mostly been failures. But if the means employed have proved inadequate or unsuitable, it does not follow that technical education in agriculture is unnecessary, or that suitable means and methods of promoting it cannot be found.

To attempt to teach the principles of agriculture to men who have no knowledge of either elementary chemistry or botany can scarcely be expected to be generally successful, nor do we hear good accounts of lectures given to farmers by men whose agricultural experience has been mainly limited to the class-room and the laboratory, and who are apt to confound agricultural chemistry with agriculture itself. Yet there are very many earnest workers on the County Councils, who have the cause of agricultural education too much at heart to let a few failures and disappointments dishearten them, and, before very long, we feel sure that they will have more reason for congratulation than at present.

Meanwhile, we can welcome this book of Dr. Munro's and wish it the success it deserves, for not only does the author avoid errors himself but he corrects a few which some other writers of elementary text-books on agriculture have fallen into. Thus, on pp. 20 and 132, he removes the impression which many beginners get (from some "cram-books" we have seen) that silica in a soluble form is very essential as a plant-food, especially to cereals. Only those who are familiar with answers to examination papers in agriculture have any idea how frequently this mistake is made.

The first part of the book, comprising five chapters, will give the reader a very good account of soils, their formation and properties; also of plant-food in the soil, how it is increased, and how rendered available for the use of plants. Included in this first part are two chapters on "Improving the Land" and "Tillage Operations," from the pen of Prof. Wrightson. These fit in well with the rest of the work.

The second part deals with the subject of manures pretty exhaustively, the author giving many illustrations from the Rothamsted experiments. The last chapter, on "Special Manures," gives instructions for valuing artificial manures from the chemical analysis, and we feel sure that the matter dealt with in this chapter will be specially useful, and do at least a little to help the farmer from being defrauded by some few unscrupulous manufacturers, still, unhappily, existent amongst us.

OUR BOOK SHELF.

Catalogue of the Specimens illustrating the Osteology of Vertebrated Animals, Recent and Extinct, contained in the Museum of the Royal College of Surgeons of England. Part III., Class Aves. By R. Bowdler Sharpe, LL.D. (London: Printed for the College and sold by Taylor and Francis, Red Lion Court, Fleet Street, 1891.)

THE first point of interest in looking into this Catalogue was to ascertain which of the innumerable schemes of bird classification had been adopted by the author; we have so many of them nowadays. Sometimes they come upon us two at a time; and to make confusion worse, aged schemes of classification, which one hoped had long ago sunk into a dishonoured grave, are sprung upon us in a fresh edition. The plan followed by Dr. Sharpe is that of Mr. Seebohm, "elaborated in his 'Birds of the Japanese Empire,'" with a few modifications. Under each order is the diagnosis; and there are a few references to the anatomical literature of the subject, which is an addition to the value of the work. These are not very full, but perhaps it is hardly necessary that they should be. A feature of this catalogue is the introduction of illustrations; there are a good many of these—48 in all. They are for the most part figures of the skull, but the syringes of a few birds and the deep plantar tendons of more are also illustrated; two figures illustrate pterylosis, and two more the under surface of the foot. The illustrations in every case are good. The Catalogue is not encumbered with huge lists of synonyms: there is only the most recently accepted name given, together with a few of the most important synonyms. The collection of bones consists of 2380 specimens, representing altogether a little over one thousand species. Some of the fossil forms are of course represented by casts only; but a number of important extinct species, notably among the Dinornithidæ, are well represented by the actual remains, in many instances the types of the species in question. We may point out to the charitably disposed that there are a number of desiderata: there are, for example, no specimens of either the African or the American "Fin-foots."

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Line Spectra of the Elements.

THE proper replies to Prof. Runge's letter in last week's issue of NATURE are three in number: viz. (1) that, as I pointed out in my former letter (NATURE of May 12, p. 29), the reasoning in my paper is valid if, as I there proved and as Prof. Runge now admits in the first sentence of his letter, Fourier's theorem can be applied to motions which approximate to non-periodic motions in any assigned degree and for any assigned time; (2) that I am not aware of anything I have written which countenances Prof. Runge's supposition that "Prof. Stoney has not noticed that a distinct property of the function is wanted in order to get a proper" [rather, a mathematically accurate] "resolution into a sum of circular functions"; and (3) that Prof. Runge is mistaken when he supposes that "the amplitudes and periods" [or frequencies] "of the single terms . . . do not approach definite values when the interval" [*i.e.* the periodic time of the recurrence required by Fourier's theorem] "increases indefinitely."

What the true state of the case is, is most easily shown as regards the frequencies of the lines; and as the proof is, I believe, new, and leads to a result of importance in the interpretation of spectra, I subjoin it.

Take a motion of the electron—

$$x = \text{The sum of partials such as} \left(a \sin \frac{2\pi kt}{j} + b \cos \frac{2\pi kt}{j}\right); \quad (1)$$

with similar expressions for the other two co-ordinates; in which the oscillation-frequencies, the k's, may be commensurable with one another, or incommensurable. If incommensurable, the motion is non-recurrent. Let this motion be arrested at intervals of T, and immediately started afresh as at the beginning. We thus obtain a recurrent motion consisting of a certain section of the motion (1) repeated over and over again. This new motion can be analyzed by Fourier's theorem, and we have to inquire what we thus obtain. Without losing anything in generality, we may confine our attention to the motion parallel to the axis of x, and to the single partial of that motion which is written out above, as all the partials lead to similar results.

Let us then examine by Fourier's method the motion which is represented by the equation—

$$x_k = a \sin \frac{2\pi kt}{j} + b \cos \frac{2\pi kt}{j} \quad . \; . \; . \; . \; . \; (2, a)$$

from $t = 0$ till $t = \mathrm{T}$, and which is repeated from that on at intervals of T. If T is a multiple of j/k, Fourier's theorem simply furnishes equation (2, a) as the complete expression for all time of the motion; so that in this case it indicates the same definite line in the spectrum as is furnished by the original partial of equation (1).

If T is not a multiple of j/k,

$$\mathrm{T} \text{ will} = (m + \alpha)\frac{j}{k},$$

where m is a whole number and α a proper fraction. Equation (2, a) then becomes

$$x_k = a \sin \frac{2\pi(m + \alpha)t}{\mathrm{T}} + b \cos \frac{2\pi(m + \alpha)t}{\mathrm{T}} \quad . \; . \; (2, b)$$

which is true from $t = 0$ till $t = \mathrm{T}$, after which the motion is to be repeated. Then, by Fourier's theorem—

$$\left.\begin{aligned} x_k = \mathrm{A}_0 + \mathrm{A}_1 \sin \frac{2\pi t}{\mathrm{T}} + \mathrm{A}_2 \sin \frac{4\pi t}{\mathrm{T}} + \; . \; . \; . \\ + \mathrm{B}_1 \sin \frac{2\pi t}{\mathrm{T}} + \mathrm{B}_2 \sin \frac{4\pi t}{\mathrm{T}} + \; . \; . \; . \end{aligned}\right\} (3)$$

is true of this motion for all time, in which

$$\mathrm{A}_n : \int_0^{\mathrm{T}} \sin^2 \frac{2\pi nt}{\mathrm{T}} \,.\, dt = a \int_0^{\mathrm{T}} \sin \frac{2\pi(m + \alpha)t}{\mathrm{T}} \,.\, \sin \frac{2\pi nt}{\mathrm{T}} \,.\, dt$$
$$+ b \int_0^{\mathrm{T}} \cos \frac{2\pi(m + \alpha)t}{\mathrm{T}} \,.\, \sin \frac{2\pi nt}{\mathrm{T}} \,.\, dt;$$

$$\mathrm{B}_n \,.\, \int_0^{\mathrm{T}} \cos^2 \frac{2\pi nt}{\mathrm{T}} \,.\, dt = a \int_0^{\mathrm{T}} \sin \frac{2\pi(m + \alpha)t}{\mathrm{T}} \,.\, \cos \frac{2\pi nt}{\mathrm{T}} \,.\, dt$$
$$+ b \int_0^{\mathrm{T}} \cos \frac{2\pi(m + \alpha)t}{\mathrm{T}} \,.\, \cos \frac{2\pi nt}{\mathrm{T}} \,.\, dt;$$

which, when integrated, give the following values for A_n and B_n—

$$\left.\begin{aligned} \mathrm{A}_n &= \frac{a \sin 2\pi\alpha - b(1 - \cos 2\pi\alpha)}{2\pi}\left(\frac{1}{d} - \frac{1}{s}\right) \\ \mathrm{B}_n &= \frac{a(1 - \cos 2\pi\alpha) + b \sin 2\pi\alpha}{2\pi}\left(\frac{1}{d} + \frac{1}{s}\right) \end{aligned}\right\} \; . \; . \; . \; (4)$$

where d stands for $(m - n + \alpha)$, and s for $(m + n + \alpha)$.

This furnishes a very remarkable spectrum, a spectrum of lines that are equidistant on a map of oscillation-frequencies, and that extend over the whole spectrum. But they are of very unequal intensities. If T is a long period, m is a high number. The lines are then ruled close to one another, and their intensities are insensible except when n is nearly equal to m, the two brightest lines being the next to the position of the original line of equation (1), one on either side of it, and the others falling off rapidly in brightness in both directions.

If we take a longer period for T, m becomes a still higher number; the lines are more closely ruled and are more suddenly bright up to those on either side of the position of the original line of equation (1), to which also they are now closer; so that, at the limit, when T increases indefinitely, equation (3) becomes a mathematical representation of the original line of equation (1).

This interesting investigation is all the more important as it gives a clue to how rulings of lines which are equidistant and brighter up to the middle may arise; and I feel sure that Prof. Runge will join me in not regretting that he expressed the doubts which led to its solution.

G. JOHNSTONE STONEY.

9 Palmerston Park, Dublin, June 3.

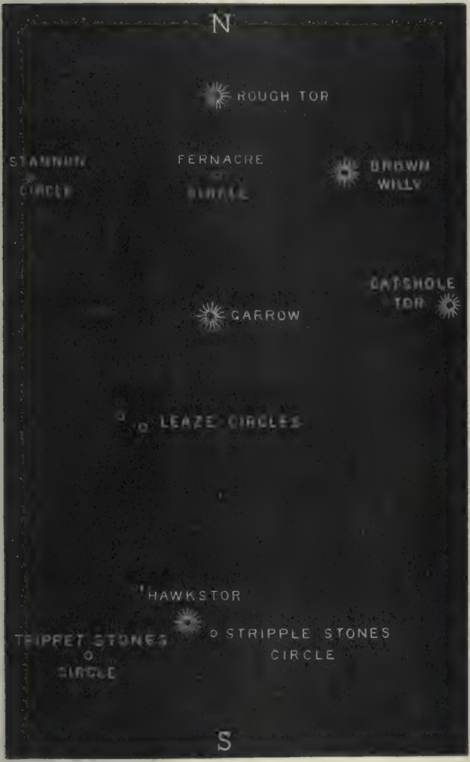
Stone Circles, the Sun, and the Stars.

ARTICLES by Mr. Norman Lockyer and Mr. Penrose, recently published in NATURE, have dealt with the positions of ancient Egyptian and Greek temples with relation to the rising sun, and to the pole star, or some star or stars in its vicinity. For some years past I have endeavoured to show, in papers read before the British Association and other Societies, that our stone circles had a relation to the rising sun, indicated usually by an outlying stone or by a notable hill-top in the direction in which the sunrise would be seen from the circle, and I have in some cases found similar indications towards the north, which may have referred to the pole or other northern star or stars. A paper containing many details as to these cases will shortly appear in the Journal of the Royal Archæological Institute.

There are six circles on Bodmin Moors, which at first sight appear to have no relation to each other, but which, if the 6-inch Ordnance map is to be relied upon, would seem to have been arranged on a definite plan (see accompanying plan).

The Stannon and Fernacre Circles are in line 1° (true) north of east with the highest point of Brown Willy, the highest hill in Cornwall; and the Stripple Stones and Fernacre Circles are in line with the summits of Garrow and Rough Tor, at right angles with the other line—namely, 1° west of (true) north. A line from the Trippet Stones Circle to the summit of Rough Tor would also pass through the centre of one of the Leaze Circles (about 12° east from true north). Other hills are in the direction of the rising sun. The Trippet Stones are 11½° south of west from the Stripple Stones, 10° east of south from the Stannon Circle, and about 13° west of south from the Fernacre Circle. The respective bearings of the other circles have already been given, and all are true (not magnetic) according to the 6-inch Ordnance map.

More remarkable, perhaps, than the position of these circles are their distances from each other, which, on the level map, are almost exactly as 3, 7½, 2, and 8, for the sides of the irregular four-sided figure, of which four of the circles form the corners, while the diagonals are of the same length within a hundred feet, the differences being much less than the 1 per cent. which Mr. Flinders Petrie has found to be the average error of ancient British and even Assyrian workmanship. The builders of these circles may be supposed to have aimed in their measurements at even numbers of some unit, and the unit which gives the best results appears to be a Royal Persian or Egyptian cubit of 25·1 inches (not at all the unit one would expect). The actual measurements, as nearly as I can get them from the 6-inch Ordnance map, are:—



	Feet.	Cubits of 25·1 inches.
Stannon Circle to Fernacre Circle ...	6275 =	3000
Fernacre Circle to Stripple Stones ... (Practically 7500 cubits)	15730 =	7520
Stripple Stones to Trippet Stones ... (Practically 2000 cubits)	4180 =	1998·4
Trippet Stones to Stannon Circle ... (Probably meant for 8000 cubits)	16575 =	7924
Diagonals.		
Fernacre Circle to Trippet Stones ...	16950 =	8103
Stannon Circle to Stripple Stones ... (Perhaps meant for 8125 cubits)	16550 =	8055

It must not be forgotten that these measurements are taken from the level map, while the ground between the circles is very irregular, but it seems more probable that the builders of these circles made allowance for the irregularities of the ground than that the distances, as shown by the map, are merely the result of accident.

If, however, the 25·1 inch cubit were the unit of measurement for the distances between the circles, it ought to appear in the measurements of the circles themselves—and it does; for the diameter of the Trippet Stones Circle is exactly fifty of such cubits, and the diameters of the Fernacre and Stripple Stones Circles are (as nearly as I can judge in their ruinous condition) seventy of such cubits.

The Egyptians appear to have constructed separate buildings for the observation of the sun and of the stars, but if the circle builders used the same circles for both purposes, placing them so that when standing in them they could see the sunrise over a fixed point on one hill, and a certain star rise over a fixed point on another hill in another direction, their system was much more economical, though perhaps less exact than that of the more civilized Egyptians.

A. L. LEWIS.

The Height of the Nacreous Cloud of January 30.

THE cloud referred to by Mr. T. W. Backhouse, in your issue of February 18 (p. 365), attracted universal attention over Eastern Yorkshire and even in Lincolnshire, so that numerous letters were sent to the *Leeds Mercury*, *Yorkshire Post*, &c.

Its general appearance in these parts is being dealt with by Mr. H. Bendelack Hewetson, of Leeds. I will therefore merely state that the intensity of the fringes surpassed anything in my previous experience. Even those observed in 1884–85, in connection with the Krakatão glows, did not approach it in this respect.

Here, as it happened, Venus lay just upon its lower edge. As this was fairly horizontal, save for a break not far from the middle, I was very pleased to get from Mr. C. J. Evans, Ackworth, near Pontefract, a second observation. In response to further appeals, observations, of varying accuracy, from the places in the subjoined table, were available for calculating the height.

Leeds (Prof. A. Lupton saw the cloud "nearly overhead," "if not, a little S.S.W.," "within 20° of the vertical"), *Ackworth*, and *York* enable us to determine the direction and position of the central part of the lower edge of the cloud as seen from the north and east. They give a point just above Mirfield Junction, 9 miles S.S.W. from Leeds, 32 miles S.W. from York and 13½ miles W. of Ackworth. The Driffield direction passes the same spot. The only other record, Market Rasen, is very divergent, the observer there putting the centre point south of west, whereas Mirfield is north of west.

The altitude of this point was capable of closer determination, thanks to references to Venus and Jupiter. The results of careful reductions are given in degrees in the following table, accompanied by the corresponding heights in miles, and distances and directions from Mirfield.

Place.	Miles from Mirfield.	Direction from Mirfield.	Altitude in degrees.	Resulting height above Mirfield.	Observer.
[1]Ackworth ...	13½	E.	40° (?45°)	11 (?13½)	C. J. Evans, &c.
[1]Tadcaster ...	22	N.E.	35°–40°	15	C. Rawson.
[1]York	32	N.E.	22½°	13½	J. E. Clark.
Wetwang ...	50	E.N.E.	16½°	15½	E. M. Cole.
Driffield ...	56	E.N.E.	10°–15°	16	J. Lovell.
Hull	54½	E. by N.	12°	13	S. Bowen.
[1]Market Rasen	58	E.S.E.	16°	15	W. Whiteman.
[1]Sunderland ...	88	N. by E.	7½°	14	T.W. Backhouse.

The adopted height from the above eight records is 14 miles, or 75,000 feet.

The Leeds record gives 25 miles, but Prof. Lupton wrote only from memory, in response to inquiry after some interval. It may, however, indicate that the south-west edge of the cloud was more nearly above Leeds. By shifting it 4 miles in that direction the Leeds height becomes 16 miles, and that for Ackworth 11½ miles, Tadcaster 12½, York 12, and the rest, except Market Rasen (unchanged), become half a mile less. The mean result, taken as before, but now including Leeds, is 13·6 miles, or substantially the same.

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[1] As the records at these stations appeared to be much the more trustworthy, *double weight* is given them in the reduced value. In the Ackworth value, four times the weight is assigned to the 40° as to the 45°, the latter, on inquiry, being stated to be less probable.

The more distant localities did not, of course, view the same *edge* as those nearer, but one which must have been rather nearer them and lower down. Thus they are subject to a positive and a negative source of error, which cannot be well estimated, but which fortunately tend to neutralize each other.

The resulting height is unexpected, but the records agree so nearly as to leave little doubt of its substantial accuracy. Mr. Backhouse's measurements were made merely for altitude and an hour later, but the cloud-shift was so slight that it has been included. J. EDMUND CLARK.

A Dust Storm at Sea.

A FEW days ago, while returning to Tokio from the southern part of Japan, I joined the s.s. *Yokohama Maru*, which, whilst crossing from Shanghai to Nagasaki had passed through a curious dust storm. Small quantities of the dust were yet to be seen in sheltered corners of the vessel. The commander, Captain R. Swain, who gave me a specimen of the material, told me that on April 2, when about 95 miles west by south of Nagasaki (long. 128° E., lat. 32° 20′ N.), at about 6 p.m. the sun appeared quite yellow. The atmosphere was moist, and rendered everything upon the deck of the ship quite damp. The precipitated moisture was yellowish, and as it dried it left an extremely fine powder. For two days previously the wind had been blowing west-south-west, or from China. Nothing was felt in the eyes, and if the ship had not been covered with yellow powder, the phenomenon would have been regarded as an ordinary but peculiarly coloured fog.

The yellow atmosphere was noticed during the afternoon of the 2nd. At midnight the wind changed to north-west—that is, from Corea. The probability, however, is that the material came from the loess plains of China. In Nagasaki, which is 390 miles from the coast of China, a yellow sun was noticed on the morning of the 2nd; and during the day, whilst dust was being precipitated, the appearance of the atmosphere was compared to that of a London fog.

On April 1 there was a fall of dust in the neighbourhood of Nawa in Okinawa-ken, and on the 2nd dust fell in Gifu—the district where the recent great earthquake took place. The P. and O. s.s. *Verona*, which left Hong Kong on April 1, experienced the same phenomenon as the *Yokohama Maru*, the vessel being covered with a fine dust, which, when suspended in the atmosphere, gave rise to so much haze that land was not seen until reaching Nagasaki. On April 3 a yellow sun was seen in Yokohama, but I am not aware that any dust was observed. Roughly speaking, it therefore seems that on April 2, at a distance of from 200 to 400 miles from the coast of China, there was a cloud of dust which may have been over 1000 miles and possibly 2000 miles in length. Dr. B. Koto, who examined a specimen, tells me that the particles are chiefly felspar, but there is a little quartz and shreds of plants. JOHN MILNE.

Tokio, April 23.

Submerged Forest.

DURING a recent visit to an East Lincolnshire seaside place, Mabelthorpe, the remains of a submerged forest were pointed out to me plainly visible at low water. On closer inspection, the stumps of fallen trees, firmly embedded in the clay from one to twenty inches above the surface could be traced along the low-water level. I should be much obliged if any reader could fix a date at which the forest was growing. Does it not prove a subsidence of land in the neighbourhood? M. H. M.

Carnivorous Caterpillars.

I SHOULD like to know if it is a known fact that some caterpillars are carnivorous, eating their own kind, and small ones of another kind? I have found on a lime-tree on our lawn, six caterpillars, two of which have done so.

One of them has (though there was plenty of food, as I had only taken it from the tree a few minutes) eaten one of its own kind about three-quarters its own size; and later on in the day a small green looper (off the lime-tree), which was in the same box. A second has eaten two small loopers. The other three I only found to-day, and they are not as large as those which had eaten their fellows.

I cannot find a description of this caterpillar in "Das Buch der Schmetterlinge" (Lutz), which I use.

They are of a bright green, the colour of the young lime leaves, with a narrow white line down the back and along each side half-way down, and a broader one lower down. Between this and the narrow side-stripe are three very small black spots; between the back line and the narrow side-line, are two black spots, to each segment. Each spot has a white edge. On the first two segments the upper two spots are one under the other; but on the rest are side by side. The three spots form an L, with the two lower ones very near, or on the broad side-line.

They have eight prolegs, as well as the two suckers at the back. They appear very irritable, and swing their heads from side to side when touched, and apparently nip other caterpillars which dare to touch them in any way.

I may also mention that there are three very fine specimens of the Red Admiral (*Vanessa Atalanta*) in our garden to-day and yesterday. JULIET N. WILLIAMS.

Blackbrook, Bickley, Kent, May 29.

THE HURRICANE IN MAURITIUS.

THE devastation caused by the hurricane in Mauritius was so terrible that it was hardly to be expected the Observatory would be spared. We are glad to say, however, that it suffered no damage; and all meteorologists will congratulate themselves that the well-known Director, Mr. Meldrum, was able without delay to prepare an account of the storm. The account is printed in the special overland edition of *The Merchants and Planters Gazette*, May 11. We here reproduce it:—

"*Saturday, April* 30.

"The hurricane which raged for a few hours yesterday, April 29, has in many respects been unprecedented in Mauritius.

"Never till now has the island been visited by a hurricane at any time between April 12 and December 1. Hitherto the hurricane season of Mauritius has been supposed to begin on the latter and to end on the former day, and till yesterday there has been no exception to the rule.

"Nor was there any sign of danger till yesterday, when the barometer began to fall rapidly and the wind to increase to a heavy gale. The suddenness, rapidity, and extent of the changes which took place in a few hours are unparalleled in the annals of the colony.

"The following table will for the present suffice to convey some idea of the changes which took place in the barometric pressure and the direction and velocity of the wind from 9 a.m. on the 24th to 9 p.m. on the 29th:—

Day and Hour.	Barometer.		Wind.	
	Cor. and reduced to sea-level.	Fall or Rise per hour cor. for var.	Mean Direction.	Velocity in miles per hour.
	Inches.			
April 24				
9 a.m.	30·059	—	E.S.E. ½ S.	3
April 27				
9 a.m.	29·903	—	E. by S.	15
April 28				
9 a.m.	·905	—	N.E. by E.	12
4 p.m.	·816	−0·003	N.E. by E.	14
9 p.m.	·850	−0·006	N.E.	12
April 29				
6 a.m.	·660	−0·018	N.E. by E.	22·4
8 ,,	·630	−0·029	N.E. ½ E.	34·7
9 ,,	·576	−0·063	N.E. by E.	35·0
10 ,,	·480	−0·094	E.N.E. ½ N.	40·0
11 ,,	·338	−0·131	N.E. by E.	52·0
Noon	·066	−0·251	N.E. ½ E.	68·0
1 p.m.	28·517	−0·532	N.E. ½ E.	96·5
2 ,,	27·990	−0·513	N.	56·0
3 ,,	28·034	+0·048	W.N.W.	68·0
4 ,,	·520	+0·483	W.S.W.	112·0
5 ,,	29·059	+0·529	S.W.	82·0
9 ,,	·719	+0·151	S. Wrd.	26·0

"In the above table the fall or rise in the barometric pressure is corrected for the daily variation, and from 9 a.m. on the 24th to 9 a.m. on the 29th the mean hourly velocities of the wind are given, whereas from 10 a.m. to 5 p.m. on the 29th the rates of the velocity per hour are given as obtained from observations taken during intervals of two to five minutes.

"It will be seen that at 2 p.m. on the 29th the barometer was at 27·990 inches; that from noon to 2 p.m. it fell 1·045 inch; that from 3 to 5 p.m. it rose 1·012 inch; and that from 5 to 9 p.m. it rose ·660 inch. The absolutely lowest pressure was 27·961 inches at 2.30 p.m., which is the lowest on record in Mauritius.

"From 9 a.m. on the 28th to 1 p.m. on the 29th the mean direction of the wind did not vary much, but it occasionally showed a tendency to veer towards north, being at times from north-east by north to north-north-east. Between 1 and 2 p.m. it on the whole veered to north, and between 2 and 3 p.m. to west-north-west, oscillating considerably, and soon after settling down at west-south-west.

"After 11 a.m. the velocity of the wind increased much, being at 1 p.m. at the rate of 96·5 miles an hour, and at 1.20 at the rate of 104 miles. But from 1.25 to 2.30 p.m. there was a lull, the velocity decreasing to the rate of 43 miles an hour at 2.33 p.m. It then began to increase again, and at 3.47 p.m. was at the rate of 121·2 miles per hour, but it soon began to abate, being at the rate of 72 miles at 5·20 p.m., 60 miles at 6 p.m., 47 miles at 7 p.m. and 26 miles at 9 p.m. By this time the weather was fine, the sky partially clear, and here and there stars shining brightly.

"Seeing that from 9 a.m. on the 24th to 9 a.m. on the 27th the barometer had fallen from 30·059 to 29·903 inches, and that the wind, though light, had veered from east-south-east half south to east by south, a note was sent to the newspapers on the latter day, stating that there was heavy weather to the northward, and that it had existed since the 24th; which, as usual in such circumstances, meant that there were indications of a cyclone away to the northward and that it was travelling from north-eastward to south-westward.

"But the wind having by 9 a.m. on the 28th reached north-east by east, and the barometer being higher on the 27th at the same hour, there was no apprehension; and in the afternoon of the 28th, the wind being still moderate from north-eastward, and the barometer falling at the rate of only 0·003 inch per hour, it was announced that there was no fear.

"As already stated, it was only on the 29th that the conditions became unfavourable, and at 9.40 a.m. a telegram was despatched announcing that the barometer was falling at an accelerating rate.

"Other telegrams, despatched at 11 a.m., announced that the velocity of the wind was at the rate of 52 miles an hour in the squalls, and that probably it would not exceed 56 miles an hour. Soon afterwards the telegraph wires were broken, and all communication ceased.

"The barometer continuing to fall at an accelerating rate, and the mean direction of the wind being nearly constant, it was inferred that the centre of the depression would, contrary to long experience (the wind being from north-east) pass over the island, and that the wind would then come from nearly the opposite direction.

"The centre, however did not pass over the Observatory, but over a point about six miles to the westward of it, and apparently from that point it travelled across the island on an east-south-easterly course.

"As a rule, when the wind is from north-eastward, there is scarcely any danger of a hurricane in Mauritius. All our great hurricanes have commenced, not with a north-easterly, but with a south-easterly wind; and this is why, when the wind was from north-east by east at 11 a.m. yesterday, and the barometer at 29·338, it was considered probable that the velocity of the wind would not exceed 56 miles an hour. On February 12 last, the barometer fell to 29·325, and the greatest velocity of the wind was 47·5 miles per hour from north-east, the barometer soon afterwards rising and the wind decreasing.

"There are, apparently, only two ways of, in a measure, accounting for the passage of the centre of a hurricane over the island yesterday from west-north-westward to east south-eastward. Firstly, the cyclone which had been travelling to the northward and north-westward of the island on a south-westerly course, from the 24th to the 27th, recurved to the southward and south-eastward; or secondly, a small secondary cyclone, which was generated in the south-east quadrant of the larger cyclone, travelled to the east-south-eastward, and bore down on Mauritius. The latter is perhaps the more probable hypothesis; for the small but violent hurricane of yesterday, with respect to its extent, duration, &c., exhibited the characteristics of a local atmospheric disturbance.

"On the night of the 27th and morning of the 28th there was a great deal of thunder and lightning, and also frequent lightning during the night of the 28th. But the hurricanes of Mauritius are seldom, if ever, immediately preceded by thunder and lightning.

"It may be stated, also, that from the 25th to the 29th there were from five to six groups of sun-spots, indicating a considerable increase of solar activity; and that from the 25th to the 28th there were large magnetic disturbances, the portion of the sun's disk on which there was a very large group of spots on February 12 being again on or near the sun's central meridian.

"C. MELDRUM."

PROFESSOR JAMES THOMSON.

PROF. JAMES THOMSON, who died on May 8, after a few days' illness, the result of a chill, was born in Belfast in 1822. He was the son of James Thomson, who was then Lecturer on, and afterwards Professor of, Mathematics in Belfast, and subsequently became Professor of Mathematics in Glasgow University. The father was a highly successful teacher and original investigator in mathematics, and was the author of many important school books. One of these books was, thirty years ago, still the recognized text-book on arithmetic in Ireland, and in all probability still retains its position. It was referred to by its very well-known title the "Thomson," by Prof. Tyndall in his British Association Address in 1874. We do not need the assurances of contemporaries, which are plentiful, that the two boys, James and William Thomson (now Lord Kelvin), made brilliant progress in their father's subject, and exhibited, even in early days, that combination of inventive genius and painstaking effort for accuracy, which have been their great characteristics since. James took his M.A. degree at Glasgow, served an apprenticeship under Sir William Fairbairn, and practised in Belfast as an engineer. He held the appointments of engineer to the Belfast Water Commissioners and to the Lagan Canal Navigation Works. In 1857 he became Professor of Civil Engineering in Queen's College, Belfast, and his Belfast pupils are to be found occupying high positions in every part of the world. He succeeded Rankine in Glasgow in 1872, and resigned the Professorship at Glasgow in 1889 because his eyesight was failing. He became a Fellow of the Royal Society in 1877. He received the honorary degrees of D.Sc. from the Queen's University of Ireland, and of LL.D. from Glasgow and from Dublin. In 1853 he married the only daughter of the late Mr. William John Hancock, J.P., of Lurgan, Co. Armagh, and it is a pathetic circumstance connected with his death, that she and one of his daughters survived him only a few days. He leaves a son and another daughter.

In his private engineering practice at Belfast, he carried out important work in hydraulic machinery for use at home and in foreign countries. He invented the inward flow vortex turbine, and even now there are men in Ulster who are willing to talk at great length about his troubles and successes with this turbine. There was no practical man, however clever, who did not at first ridicule the scientific young gentleman who proposed to replace an eighty foot wheel by a tiny turbine, whose wheel was less than a foot in diameter. He never in his life could have had a happier moment than that in which, surrounded by crowds of astonished rustics and practical engineers, he saw this tiny wheel in its very first trial, driving the machinery of a large mill. And now, wherever turbines are to be found all over the world, they are mostly "Thomson" turbines, made on the principles so clearly thought out and described by him, albeit they are known under many very different names. His notions on such subjects as strength of materials and the effect of initial strains in materials, although published forty-four years ago, have only lately become the notions of practical engineers. At that early date, his ideas on many of the applications of science in engineering were very clear and correct, and far in advance of his contemporaries. He is especially to be recognized for his services in practical hydrodynamics, a subject in which there has been a more misleading appearance of mathematical theory than in any other branch of engineering. To one of Thomson's pupils it is positively painful to take up any authoritative treatise on hydraulic machinery, for he knows that nearly every page of troublesome mathematical reasoning is based on some absurd assumption, and that James Thomson's few propositions are almost the only ones on which the engineer can rely. James Thomson seemed to fear the misuse by young engineers of the recognized mathematical methods of attacking physical problems. He, himself, when he used mathematical expressions, used them merely to put before others the results of his own method of reasoning. It expresses only a part of the truth to say that he thought about things geometrically rather than algebraically. He refrained from publication until his proof was perfect, and some of his pupils may feel sorry that they have not more faithfully followed their master's example. A study of his successive manuscript proofs of his law of flow of fluids from similar orifices would probably enable us to conceive of the habits of thought of the Greek geometers: every word and phrase is carefully selected, and considered time after time with a view to perfect accuracy. Such invention and such regard for perfection of detail were surely never combined before.

When any of his speculations has been once published in an authoritative text-book, it will be noticed that it appears in all text-books published subsequently; the melting point of ice, the triple point in water-stuff, the continuity in the steam water isothermal, the tears of strong wine, are a few examples. No doubt, as time goes on, text-book writers will find that he discovered other important things. He was such a very observant man that he often put forward his most important propositions when explaining phenomena that seemed utterly insignificant. Let the reader only think that what occurs in a wash-basin, or in a little rivulet near the sea, may be of great importance scientifically, and let him read again some of Thomson's insignificant-looking scattered papers, and he will find important propositions published which will not, perhaps, for some years yet, find their proper positions in the text-books.

Of the history of thermodynamics during the eventful years 1849–50, who dares now to say anything? Nor can anyone now say anything about the great glacier dispute. One thing is certain, however, that James Thomson's discovery of the necessary lowering of the melting-point of ice with pressure, published on January 2, 1849, settled for ever the theory of the flow of glaciers. Joule's work was beginning to be known, but Thomson, in his proof, like Lord Kelvin in the well-known paper published on the same day, adopts Carnot's idea of the conservation of heat. A change in one expression, not essential to the proof itself, was all that was needed after the first and second laws of thermodynamics had been recognized. Of his various papers on hydrodynamics, capillarity, heat, light, and the states of matter, published since that time, we have not space to say more than that each of them made a substantial addition to our knowledge. His latest work, the Bakerian Lecture this year of the Royal Society, on "The Grand Currents of Atmospheric Circulation," is such a paper as we might expect from a man who had given more than thirty-five years of study to the subject, that subject being one which was peculiarly his own. It is possible that the practical engineer, judging from the title merely, may neglect to read a paper which is one of phenomenal importance to the engineer as well as to the physiographer.

He was a man of singular purity of mind and simplicity of character, very clear-sighted in all that pertained to moral right and wrong, and conscientious to a degree. In his presence one felt in a purer atmosphere, where mean things seemed impossible. No Professor was ever so willing to take trouble (not mere momentary trouble, but trouble of days and nights) in the interests of a student, but no Professor was ever so rigidly exact in giving certificates and testimonials. The present writer has talked often with his old pupils about him, but never met one of them, who, besides a great respect, had not also a genuine and kindly and pleasurable love for his old Professor, whose kindness and patience had been unfailing, and whose sympathy had many a time been extended to him. How useless it is to speak of the good done to the world by a man of his character. Every one of his pupils, in however small or great a degree, is extending the range of his influence.

JEAN SERVAIS STAS.

THE regret expressed in the obituary notice of Jean Servais Stas, that we had not the exact words of his famous discourse delivered before the King of the Belgians, has attracted the attention of a correspondent, who has very courteously sent us the text of the speech.

It was delivered by J. S. Stas in his capacity of President of the Royal Academy of Sciences, and was addressed to the King at the New Year's reception, January 1, 1891. We have much pleasure in laying a translation of it before our readers:—

"Sire,

"The Royal Academy of Science, Literature, and the Fine Arts expresses its sincere wishes for the happiness of your Majesty, and the prosperity of your reign.

"As the central organ of the intellectual movement of the country, the Academy seeks to comprise within its arms the most varied talents, and to remain always an adequate and living expression of the entire activity of the human mind.

"This is both its duty and the reason for its existence.

"In the sphere of Literature and Art its voice is almost always safely guided by public opinion—a competent judge of works accessible to all.

"It is otherwise in the sphere of Science.

"The physical, mathematical, and natural sciences, and even the moral and political sciences, do not appeal in the same degree to public opinion. If their conquests radiate afar, if they incessantly modify the conditions of social existence, they themselves develop in restricted circles, and work out of sight and of knowledge of the multitude.

"The Universities, Sire, in our country especially, are the principal foci of scientific life. There not only the men of science of the future are trained, but the present representatives of higher research work, create, and distinguish themselves. There also the Royal Academy by preference seeks its fellows to associate them in its task and to render it fruitful.

"Its mission cannot be divorced from that of the institutions for higher education, and their lustre and their decline are simultaneous.

"In the name of this great and twofold interest the President of the Royal Academy feels bound to call the attention of your Majesty to the mode of appointment to the professorial chairs in the State Universities.

"The method adopted is absolutely faulty, and it affords to Science none of those guarantees which she has a right to demand.

"The intensity of party strife has the effect of absorbing into its vortex even those acts of the public authorities which ought to be least open to its influence. In place of conferring the University chairs upon the most capable men as their rightful prerogative, with the sole thought of raising the level of studies and of enlarging the intellectual patrimony of mankind, we too often see the spirit of faction disposing of such positions arbitrarily, to the injury of the scientific spirit.

"An incompetent professor paralyzes for a quarter of a century, even if he does not kill, instruction in the department committed to him. An improper nominee is a denial of justice.

"The courts of law have been invested with the right of presentation to vacant judgeships; an analogous prerogative ought to be conferred on the faculties of the Universities. Their choice would then be dictated by considerations essentially scientific, and to this end the Royal Academy relies on the great influence of the King."

"The King," adds the *Indépendance Belge*, "did not accept this appeal to his influence, and the Ministers present bestowed black looks upon the President of the Academy."

This impressive discourse has its lessons for us also, as it emphasizes the necessity of conferring scientific appointments purely in accordance *rebus gestis*, and in consideration of the actual work done by the candidate.

W. C.

NOTES.

The annual *conversazione* of the Royal Society will be held on Wednesday, June 15.

At the annual meeting for the election of Fellows, held on Thursday last, the Royal Society elected the fifteen candidates whose names, with the statement of their qualifications, we have already printed.

The British Medical Association will hold its sixtieth annual meeting at Nottingham on July 26, and the three following days. Mr. Joseph White, consulting surgeon of the Nottingham General Hospital, will preside. Addresses will be given, in medicine, by Prof. James Cumming, of Queen's College, Belfast; in surgery, by Prof. W. H. Hingston, of Montreal; and in bacteriology, by Dr. G. Sims Woodhead, of the Research Laboratory of the Colleges of Physicians and Surgeons, England. The scientific work of the meeting will be done in ten sections.

At a meeting of the American Philosophical Society, Philadelphia, on May 20, it was decided that the one hundred and fiftieth anniversary of the foundation of the Society should be worthily celebrated in 1893, and a committee was appointed to make the necessary arrangements.

The Federated Institution of Mining Engineers held their general meeting in London on Thursday and Friday last. At the meeting on Thursday papers were read on "Gold Mining in New Zealand," by G. J. Binns, and on "Petroleum in Eastern Europe and the Method of Drilling for it," by A. W. Eastlake. Prof. T. E. Thorpe gave some practical demonstrations of the action of coal-dust when exploded with gas. The members visited the Electrical Exhibition at the Crystal Palace in the afternoon, and dined together at the Garden Hall in the evening. Among the papers read at the meeting on Friday were papers on "The Causes of Spontaneous Combustion of Coal and Prevention of Explosion on Ships," by M. V. Jones; "A Safety-cage for Mines and Hoists," by J. Whitelaw; "Winding by Water-balance at Ynis Merthyr Colliery," by M. W. Davies; and "Gold Milling," by W. F. Wilkinson.

The Aldini Medal for Animal Electricity has been awarded to Dr. A. Waller, Lecturer on Physiology, St. Mary's Hospital Medical School, by the Bologna Academy of Sciences.

The Council of the Institution of Electrical Engineers decided that the Salomons Scholarship of £35 should be given to a second year's student training to become an electrical engineer at either King's College, University College, the City and Guilds Central Institution, or the Finsbury Technical College. The first award has just been made to C. H. C. Woodhouse, Matriculated Student of the Central Institution, Associate of the Royal College of Science, and B.Sc. of the London University.

At the annual meeting of the Institution of Civil Engineers Mr. Harrison Hayter was elected to act as President for the ensuing year. The Vice-Presidents are Alfred Giles, Sir Robert Rawlinson, Sir Benjamin Baker, F.R.S., and Sir Jas. N. Douglass, F.R.S. The following are the other members of Council:—W. Anderson, F.R.S., J. Wolfe Barry, Alex. R. Binnie, E. A. Cowper, Sir Douglas Fox, J. C. Hawkshaw, Charles Hawksley, Sir Bradford Leslie, George Fosbery Lyster, James Mansergh, Sir Guildford L. Molesworth, W. H. Preece, F.R.S., Sir Edward J. Reed, F.R.S., William Shelford, and Francis W. Webb.

In the official abstract of the report of the Council of the Institution of Civil Engineers for the session 1891–92, it is stated that 59 associate members had been transferred to the class of member, and that there had been elected 3 honorary members, 28 members, 324 associate members, and 7 associates, while 4 associate members had been restored to the register. These additions together amounted to 366. After deducting 145 names from deaths, resignations, and erasures, there was an increase of 221, bringing up the total number on the register to 5371, as against 5150 at the corresponding date last year. This enumeration was irrespective of the students, of whom 200 had been admitted during the year, as against 166 for the previous twelve months; but during this period, 106 students had become associate members, and 140 had disappeared from the list, so that the number now on the books was only 868, whereas last year the number was 914. Thus, including students, the total number on the books was now 6239, as against 6064 twelve months ago. The following awards have been made to the authors of papers which have been discussed:—A George Stephenson Medal and a Telford Premium to Mr. Alex. R. Binnie; Telford Medals and Telford Premiums to Mr. A. P. Trotter and Mr. W. T. Douglass; and Telford Premiums to Messrs. H. Alfred Roechling, A. H. Curtis, W. Airy, H. Gill, and Prof. W. C. Roberts-Austen. In respect of communications which have been deemed suitable for printing without being discussed, Telford Medals and Telford Premiums had been adjudged to

Messrs. F. Fox and Alfred W. Szlumper; and Telford Premiums to Messrs. Sheibner, T. H. Beare, W. C. Unwin, E. Penny, A. D. Stewart, R. H. B. Downes, and W. Matthews. The Howard Quinquennial Prize had been awarded to Sir Isaac Lowthian Bell, Bart., F.R.S., for his treatise on "The Principles involved in the Manufacture of Iron and Steel." The papers read at supplemental meetings of students had shown in nearly every case evidence of having been prepared with care. Three, at least, were of high merit, and, with four others above the average, had been deemed worthy of publication, either in whole or in part, in the Minutes of Proceedings. For these seven papers the Council have awarded the Miller Scholarship to Mr. H. B. Ransom for his paper on "Fly-Wheels and Governors," and Miller Prizes to Messrs. C. H. Wordingham, E. L. Hill, D. Carnegie, G. H. Sheffield, J. B. Ball, and R. J. Durley.

AT the second annual dinner of the Institute of Marine Engineers, held last Thursday, Lord Kelvin, the President, said in the course of his inaugural address that the institution was one which he thought could not fail to be of the greatest service to the cause of marine engineering. He had only to go back to the days of his youth to recall the immense strides which had been made in this great industry. His father was an Irishman, as he himself was, and he used to cross the Channel from his home in county Down as best he could to land at some point on the coast of Scotland and find his way to the University of Glasgow, there to pursue his studies. He used to make the passage in whatever sailing vessel he could find taking the cattle across, and the time of the passage was not part of the bargain. On one occasion he sailed from Belfast to Greenock in twelve hours; on another he was four days on the passage, and sailed three times round Ailsa Craig. It was only necessary to state such facts to show how vast had been the progress since those days. No branch of engineering, no branch of science which aimed at supplying the wants of mankind, had made greater progress in the last sixty years than that. He was not forgetting railways or telegraphs; but he said advisedly that no branch of engineering had made greater or more splendid strides than marine engineering.

MISS DOBERCK, who has been appointed assistant meteorologist in Hong Kong, is the sister, not the daughter, of the present Director of the Hong Kong Meteorological Observatory.

ACCORDING to a telegram from Naples, dated June 7, the eruption of Mount Vesuvius, which had been noticeable for some little time, had considerably increased in volume, and large masses of lava were flowing into the Atrio di Cavallo ravine.

ON June 7, at 12.30 a.m., an earthquake shock was felt at San Severo, in the province of Foggia, and an adjoining hamlet. The oscillations, which were of an undulatory character, created a temporary panic.

THE weather during the first part of the past week has been fine over the eastern and southern portions of England, but unsettled in Ireland and Scotland, with a considerable amount of rainfall, while the temperature was much lower, generally, than in the previous week, the daily maxima not exceeding 70°. On the morning of the 4th a disturbance appeared off the Irish coast and crossed our islands on Sunday, causing heavy rain in places, and thunderstorms in the eastern parts of England. The *Weekly Weather Report* for the week ending the 4th instant shows that during that period the rainfall exceeded the mean in all districts, excepting the east of England, where bright sunshine was very prevalent. Over Ireland and in the north of Scotland the excess above the normal rainfall was large, being 1·2 inch and 0·8 inch respectively, yet, reckoning from the beginning of the year, there was still a deficiency in all districts. On Monday, the 6th, a great increase of temperature occurred in most parts of this country, and the weather became much more settled, under the influence of an anticyclone which approached our islands from the southward, while the shade temperature in London reached 73° and 74° at Loughborough. During the early part of this week, the anticyclone became well established, and had caused the temperature to rise considerably in Scotland and Ireland, with prospects of settled, fine weather, generally.

MR. R. H. SCOTT has contributed an article, entitled "Notes on the Climate of the British Isles," to *Longman's Magazine*. The author gives some amusing instances of the distortion of facts at seaside stations, where the observers are anxious to prove the advantages of their own towns over those of their rivals. Taking the whole year round, the warmest spot is the Scilly Isles, which are a degree warmer than either the west of Cornwall or the Channel Islands; while the coldest region on the coast is the extreme north-east of Aberdeenshire. In winter very little difference of temperature is met with all along the east coast; but the coldest part of England lies round the Wash. With regard to the variability of temperature, or the difference of the mean temperature of an entire day, the equability of the temperature of these islands is very great. The only locality for which a more uniform temperature has yet been published is Georgetown (Demerara); the figure for this place is 1°·1, while for London it is 2°·7. All the great changes of temperature occur in winter, and accompany sudden thaws. As regards bright sunshine, the Channel Islands are by far the most favoured. On the mean of the whole year, Jersey secures 39 per cent.; but from the Bristol Channel to the coast of Norfolk there is but little difference in the amounts recorded. In cities like London the deficiency is due to smoke. The statistics relating to fog are not yet completely discussed, but so far as they go they show that in winter the foggiest district is the east coast of England. Next come London and Oxford, which are about equal. With regard to rainfall the east coast stations receive on an average of the whole year about half as much as those on the west coast, the amount being about 25 inches on the east coast, 30 to 40 inches between Sussex and Devonshire, and 50 inches to the south of Cornwall. In the west of Ireland the amount rises to 70 or 80 inches, owing to high land near the coast. The driest hour almost everywhere is noon.

MR. C. MICHIE SMITH has edited a work embodying "Results of the Meteorological Observations made at the Government Observatory, Madras, during the years 1861–90, under the direction of the late Mr. Norman Robert Pogson." The volume is published by order of the Government of Madras. It was Mr. Pogson's intention to issue the work as soon as he could after the completion of thirty years of observation, and at the time of his death a considerable part of the manuscript was nearly ready for press. In editing the work, Mr. Smith, so far as possible, has retained the original plan. He expresses much admiration for the skill and thoroughness with which the observations were organized and carried out.

THE Essex Field Club will probably hold its first dredging meeting of the season at Brightlingsea on Friday and Saturday, June 24 and 25. Other field meetings in course of arrangement are: Visit to Dagenham district (June or July); the Writtle Woods (July 30); Rochford and Rayleigh (August); on the Stour from Bures to Manningtree; visit to the Deneholes, &c.

THE Clarendon Press will publish immediately a second volume of Prof. Weismann's work on "Heredity and Kindred Biological Problems." It contains four essays, of which only the shortest has previously appeared in an English form (in the columns of NATURE). The first essay deals with degeneration, and clearly shows, by abundant illustrations, that it has resulted from *panmixia*, or the cessation of natural selection. The second is an attempt to explain the development of the art of music, and to show that the hereditary transmission of the results of practice is quite unnecessary in order to account for its rise. The third contains a reply to certain objections urged by Prof. Vines. It will be useful in giving clearer expression to the ideas on the death of multicellular beings and the immortality of the unicellular. The fourth and last essay is by far the longest and most important. It deals with the essential significance of sexual reproduction and conjugation, &c., as inferred from the results of the most recent researches. Prof. Weismann's older views on these subjects (especially concerning the polar bodies) have been modified and in part abandoned. The immortality of unicellular beings and the question of the transmission of acquired characters by them are also discussed in detail with reference to recent observations.

WE have received the first volume of the *Jahrbuch der Chemie*, a new periodical issued by the Frankfort publisher H. Bechhold. The editor is Prof. Richard Meyer, of Brunswick. Chemistry is now divided into so many departments that it is difficult for specialists to obtain an accurate idea of the recent progress of the science as a whole. The object of the *Jahrbuch* is to supply this need, and, if we may judge from the first issue, the work is likely to fulfil its purpose admirably. The editor has secured the co-operation of many well-known chemists, each of whom presents a general view of what was done last year in the department of research to which he himself is more particularly devoted. Thus there are, among other papers, reports on physical chemistry, by W. Nernst; on inorganic chemistry, by G. Krüss; on organic chemistry, by C. A. Bischoff; on physiological chemistry, by F. Röhmann; on pharmaceutical chemistry, by H. Beckurts; on agricultural chemistry, by E. F. Dürre; on explosives, by C. Häussermann; and on photography, by J. M. Eder and E. Valenta. In future issues the editor hopes to include the bibliography of each branch of the subject.

THE new number of Wundt's *Philosophische Studien* opens with a comprehensive paper by the editor on "Hypnotism and Suggestion." The subject is treated from the double standpoint of physiology and psychology; and the article should go far towards bringing about a saner tone of thought than that which is just now current, even in "educated circles." Mr. Titchener's chronometrical determinations reduce the recognition time of colours to 30, of letters and short words to 50 thousandths of a second. Dr. Merkel's article on the psychophysical error-methods is concluded; and Drs. Külpe and Kirschmann publish the results of a careful testing of the Hipp chronoscope (old pattern) by means of a new control-hammer.

ON Sunday last a terrible disaster overtook the petroleum district in Pennsylvania, especially the places called Oil City and Titusville. A thunderstorm, accompanied by torrents of rain, broke over the district, and the two cities were so quickly inundated by the swollen waters of Oil Creek that it was difficult for the inhabitants to escape to the hills, and many were drowned. Several refineries were struck by lightning, so that the unfortunate towns were devastated equally by fire and by water. It is supposed that about 200 persons lost their lives, while the destruction of property was enormous.

THE gallery in the South Kensington Museum assigned to the large collection of wrought iron work which has for some time been closed for rearrangement, was re-opened to the public on Whit Monday. The larger grilles and screens, including the gates from Hampton Court, are now placed in the arched spaces on either side, while the lanterns, cressets, signs, &c., are suspended along the gallery, smaller objects being shown in sloping glass cases. Among these last is a curious series of rush-candle holders, tobacco tongs, and other domestic implements used in England, chiefly in the eighteenth century, collected and lent by Lady Dorothy Nevill. Examples of the locksmith's art, English, French, and German, are numerous, including some chiselled steel locks and keys from old French buildings, but produced by "Johannes Wilkes de Birmingham" in the seventeenth century. Some of the more famous specimens of mediæval work in English cathedrals have been reproduced in facsimile. A hand-book on "Decorative Iron Work," prepared by Mr. Starkie Gardner, will shortly be published.

THE Board of Directors of the Zoological Society of Philadelphia have issued their twentieth report, and are able to give a good account of their work during the past year. Among the changes of the year was the establishment of "a cheap day," the price of admission on Saturdays and holidays (except the Fourth of July), having been fixed at ten cents for adults and five for children. The result has been satisfactory, the attendance having increased considerably, while there has been no material financial loss. Another fact noted in the report is that an offer of free admission to the Garden was made to the Board of Education for such classes of pupils of the public schools as seemed to the Board likely to profit by the privilege. Under the arrangement entered into, nearly ten thousand scholars of the public schools were admitted between September 23, when tickets were issued, and March 1, the end of the Society's fiscal year.

THE botanical section of the Imperial Museum of Natural History at Vienna is about to issue, under the name "Cryptogamæ, Exsiccatæ," a collection of named Cryptogams to its contributors, and in exchange for other similar collections.

THE Indian papers report that, under the auspices of the Government and Secretary of State for India, an important work, illustrative of the famous Ajanta Cave mural paintings, will be published shortly. The bulk of the work will consist of 173 imperial folio plates, mostly produced in chromo-collotype, by Mr. Griggs, of Peckham, the accompanying text being from the pen of Mr. John Griffiths and Dr. James Burgess, C.I.E.

FROM an official return just published it appears that during 1891 the total number of persons killed in the Punjab by wild beasts and snakes was 861, or one less than during the previous year. The great majority died of snake-bite, only 65 deaths being attributed to wild beasts. On the other hand, of the 966 cattle reported to have been destroyed, only 38 were killed by snakes.

MR. W. S. KEY calls attention, in the American journal *Electricity*, to the difficulty which manufacturers of electrical devices in the United States experience in obtaining iron adapted for electrical purposes. They complain of the inferior quality of the iron, the trouble in obtaining such brands as are in every way suitable, magnetically considered, for use in electrical devices such as dynamo and motor armatures, transformers, &c. They also complain of the irregular and unsatisfactory manner in which it is too generally annealed and finished by rolling, scaling, &c. Some of these manufacturers have for years used imported English, Welsh, and Swedish iron, which is necessarily of high price. They have also used Pennsylvania iron of high quality, but as yet have failed to discover just the quality they need. Mr. Key's experience in connection with a well-known firm in England has convinced him that iron such as is wanted in electrical manufactures might be produced if proper methods were adopted. "To secure such iron," he says, "of course a full and accurate knowledge of the qualities of the various brands of pig-iron now on the market would be a prime requisite; none the less would a correct knowledge of mixing be essential, while the rolling, scaling, and annealing would all have to be very carefully attended to if satisfactory results were to be attained."

An important series of bibliographies relating to the more prominent groups of the languages of the North American Indians, by J. C. Pilling, is being issued by the Smithsonian Institution. The numbers concerning the Eskimauan, Siouan, Iroquoian, and Muskogean families are already known to students of these languages; and now a fifth number, giving the bibliography of the Algonquian languages, has been published. The sixth will include the languages belonging to the Athapascan stock. The volume on the Algonquian languages contains 2245 titular entries, of which 1926 relate to printed books and articles, and 319 to manuscripts. It consists of 614 closely-printed pages, and represents an amount of well-directed labour for which Mr. Pilling deserves the cordial recognition of all who will in any way profit by his researches.

The atomic weight of copper has been redetermined by Dr. Richards, and an account of his work will be found in two papers contributed to the new *Zeitschrift für Anorganische Chemie* (pp. 150 and 187). From the results of experiments concerning the replacement of silver in silver nitrate by metallic copper, Dr. Richards was led to believe that the number usually accepted for copper, 63·3, was considerably too low. He has, therefore, thoroughly investigated the methods by which the old number was obtained, and made a new series of determinations, in which corrections have been applied for the errors due to the mode of analysis adopted. In the year 1874 Hampe made two series of determinations of the atomic weight of this element. One of these, in which the amount of metallic copper contained in copper oxide was estimated, gave the value 63·34; the second, which depended upon the copper content of anhydrous copper sulphate, yielded the number 63·32. The lower of these values has since been generally accepted as representing most probably the true atomic weight of copper, on account of the extreme manipulative care taken by Hampe, and the remarkable agreement of the individual experiments. Dr. Richards, however, has discovered a flaw in the method. Hampe dried his sulphate of copper at 250°; but Dr. Richards has experimentally proved that the so-called anhydrous sulphate obtained at this temperature loses about 0·17 per cent. of its weight when heated to the temperature of the vapour of boiling mercury. This loss, moreover, when taken into account in calculating the atomic weight, brings up the figure almost exactly to that indicated by the replacement of silver experiments. An exhaustive investigation has eventually shown that copper sulphate retains 0·12 per cent. of its water of crystallization, even after it has been subjected to a temperature of 400°. Indeed, this last trace of water is only eliminated at a temperature at which the sulphate itself commences to decompose. Dr. Richards has therefore made a series of redeterminations of the atomic weight by Hampe's method, drying the salt at 250°–270°. On calculating directly from the figures obtained, the experiments gave the mean value 63·35, a result almost identical with that of Hampe. But upon applying the correction for the slight amount of water still retained at this temperature the mean value is raised to 63·60.

In the second communication Dr. Richards discusses the mode of determining the atomic weight by ascertaining the amount of copper contained in copper oxide. He shows that copper oxide which is prepared by the method employed by Hampe, ignition of the oxynitrate, contains four or five times its volume of occluded gases, and that even at a bright red heat only a portion of this occluded gas can be expelled. Dr. Richards has therefore made a series of redeterminations by this method, applying the necessary correction for occluded gas, the correction having been very accurately ascertained from a large number of observations. The final mean value of the atomic weight of copper afforded by the whole of Dr. Richards's experiments is 63·604 (oxygen = 16), the maximum and minimum values being 63·609 and 63·600 respectively. If the value of oxygen is taken as 15·96, that of copper becomes 63·44.

The additions to the Zoological Society's Gardens during the past week include two Four-horned Antelopes (*Tetraceros quadricornis* ♂ ♀) from India, presented by Mr. H. M. Phipson, C.M.Z.S.; a Huanaco (*Lama huanacos* ♂) from Bolivia, presented by Mr. Frank Parish, F.Z.S.; a Black-necked Hare (*Lepus nigricollis*) from Ceylon, presented by Mr. T. C. Kellock; a Common Squirrel (*Sciurus vulgaris*), British, presented by Miss Ruxton; a Masked Parrakeet (*Pyrrhulopsis personata*) from the Fiji Islands, presented by Mr. A. B. Holdsworth; a Booted Eagle (*Nisaëtus pennatus*), European, presented by Lieutenant J. E. Rhodes; a Kestrel (*Tinnunculus alaudarius*), British, presented by Mr. Frank Allen; a European Pond Tortoise (*Emys europæa*), European, presented by Miss Lilian Powell; two Alligators (*Alligator mississippiensis*, jv.) from Florida, presented by Mr. R. White; a Moloch Lizard (*Moloch horridus*) from Australia, presented by Mr. John McLey; a Llama (*Lama peruana* ♂) from Peru, an Ostrich (*Struthio camelus* ♂) from Africa, a One-wattled Cassowary (*Casuarius uniappendiculatus*), a Common Crowned Pigeon (*Goura coronata* ♂) from New Guinea, two Victoria Crowned Pigeons (*Goura victoriæ* ♂ ♀), from the Island of Jobie, two Narrow-barred Pigeons (*Macropygia leptogrammica*) from Java, two Pale-headed Parrakeets (*Platycercus pallidiceps*) from North-East Australia, two Roseate Spoonbills (*Platalea ajaja*) from South America, two Vociferous Sea Eagles (*Haliaëtus vocifer*) from West Africa, purchased; a Japanese Deer (*Cervus sika*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Light-Variations of Y Cygni.—The *British Astronomical Journal*, No. 266, contains two contributions from Mr. S. Yendell and Prof. Dunér, the former "On some observed minima of Y Cygni," and the latter "On the chief cause of the anomalies in the light-variations of Y Cygni." Mr. Yendell in his paper thoroughly agrees with the explanation put forward by Prof. Dunér to account for the anomalies in the light-variations, and says that, when the two series of observations are taken simultaneously, "the substantial correctness of his (Dunér's) fundamental assumption appears to me to be proved beyond the possibility of a cavil." It may be remembered that, in Prof. Dunér's former paper on this subject, he was struck with the discordance of some of Mr. Yendell's observations, which did not seem to harmonize with his own suggested explanation. These observations are now published in detail in this paper, and will be read with interest by those who are following up this curious variable.

Prof. Dunér, in a few words, discusses the results obtained when his own observations are compared with those of Mr. Yendell. The differences between the observed and calculated times of minima showed a decided rate of change, the mean rate being −0·023d., but lacked regularity. In one case the jump from one epoch to another amounted to a rate of − 0·056d., but he thinks that this may be accounted for by a variation in Mr. Yendell's method of observing, for other observations show altogether nearly constant deviations; indeed, "it will be more correct to attribute the discordance simply to errors of observation, than to anomalies in the light-variations of the star."

Active Lunar Volcanoes?—Prof. Pickering, in the *Observatory* for this month, raises the question of active lunar volcanoes, from some recent observations made with the 13-inch Clark, using powers varying from 800–1200. Examining first the Mare Serenitatis, of 67 craters 32 were found common to both charts, 24 on Neison's and not on Prof. Pickering's, while 11 were found on Prof. Pickering's and not recorded by Neison. With higher powers, all Neison's, except two, were discovered, and, in addition, several other small ones. Just about the region of Bessel a change seems to have taken place since Neison made his map, for there are one or two cases in which the crater-pits picked out by him for reference are now not the most conspicuous objects, there being several others far more prominent in the immediate vicinity. The floor of Plato also has been carefully scrutinized, and several of what were then more or less distinct luminous points are now either invisible or barely so, while one large crater was seen where previously none was recorded. Whether a real change has taken place in these parts of the moon's surface, or whether the antecedent observations were sufficiently accurate, is a matter of doubt, and it is for future observers to determine this. But now, as Prof. Pickering says, "that we are able to study the smaller lunar craters to advantage, and so many changes are noted, it does not seem as if the same cause (the mere action of sunlight) can have affected so many of them in the same way, nor does it seem as if all the changes noted can be due to erroneous delineation."

CATALOGUE OF NEBULÆ.—In *Astronomische Nachrichten*, No. 3094, the Catalogue No. 10 of nebulæ discovered at the Warner Observatory by Swift is inserted. The number included, which generally consists of one hundred, amounts here to sixty, the reason being that owing to the increasing number of electric street lights these faint objects are rendered invisible by the illumination of the atmosphere.

GEOGRAPHICAL NOTES.

DR. HENRY SCHLICHTER contributes a valuable epitome of our knowledge of the pygmies of Africa to the June number of the *Scottish Geographical Magazine*. He divides the dwarf tribes hitherto reported into four great groups, according to the regions they inhabit, recognizing, however, the probability of further exploration revealing connecting links between them. The first group, or dwarfs of West Africa, includes the Obongo, Akoa, and Babongo, which vary between 4 and 5 feet in height. The second, or Central African group, contains the Akka, Wambutti, and Batua, of even smaller stature, inhabiting the Congo Basin, scattered amongst Bantu tribes. The third group is that of the East African pygmies, whose existence east of the Nile and south of Kaffa was reported as early as 1826; but they are still little known. The fourth group, those dwelling south of the Congo basin, is relegated to another paper.

ORDNANCE MAPS of Great Britain are at last coming prominently before the public. Although not likely to gratify those engaged in producing the sheets, popular attention will doubtless result in direct and early benefit to cartography and even to geography at large. A Parliamentary Committee, on which scientific geographers are well represented, has the whole matter under investigation, and the energetic criticisms of Mr. Crook, which have so long passed unheeded, are now receiving further expression in a series of articles in the *Times*. The particular object of attack is the new quarter-inch outline map of England and Wales, a map put forward by the Survey with some natural diffidence, for it is founded on measurements the most recent of which were made twenty years ago, and the earliest at the very beginning of the century. The delineation of the country, in consequence of the want of subsequent revision, resembles a star-chart, in so far as it represents each point as it existed at some different time in the past. Unlike a star-chart, however, the quarter-inch map of England is of no scientific and little practical value. The more thoroughly this matter is investigated, and the more speedily it is rectified, the better will it be for the Survey officers, whose magnificent triangulations and unparalleled accuracy of observation have made the mapping of the British Islands a model for the world to admire. It is high time that steps be taken for regular periodical revision of all Ordnance maps, and for publication in a form comparable with that of the Staff maps of France and other Continental nations.

AN appreciative article on the late Prof. Freeman and his services to geography appears in the June number of the *Proceedings* of the Royal Geographical Society. Freeman's most important service was to demonstrate that the physical geography of a region largely determines the political geography of the countries upon it, and that a knowledge of past geographical conditions is essential in order to understand history.

THE report of an expedition to Argentine Tierra del Fuego by Señor Julio Popper has been recently published by the Argentine Geographical Society. The region in question is the eastern half of Tierra del Fuego, the geological structure of which is mainly Tertiary rocks much disintegrated; the coast line is little indented, with few harbours, the sea shallow and abounding in sand-banks, while the climate, dominated by the warm Brazil current, is equable and moist. The south coast bordering the Beagle Channel is rugged, rocky, and under the climatic influence of the cold Antarctic drift. The tribes inhabiting the island of Tierra del Fuego proper are the Ona (compare NATURE, xlv. 577), who are described as of fine physique, resembling the Indians of North America, and susceptible of civilization. Indeed, Señor Popper contrasts their magnanimous and forgiving character very favourably with the unreasoning cruelty of the white gold-seekers who have invaded their territory, yet the Onas are said to be inveterate thieves. The map accompanying this report is covered with new names for features already designated, and it can hardly be expected that these will be accepted by European geographers.

MRS. BISHOP (Miss Bird) read an interesting paper on her recent journey to Little Tibet, before the London branch of the Royal Scottish Geographical Society, on May 31, the Duke of Argyll presiding. Lady travellers are not encouraged to describe their expeditions to the Royal Geographical Society, and as the British Association, which receives communications from men and women on an equal footing, cannot meet in London, this opportunity for a metropolitan audience to hear at first hand the account of an adventurous journey, and the sympathetic estimate of the inhabitants of a little-known region, by a woman of Mrs. Bishop's tried courage and trained observing powers was naturally taken advantage of to the utmost.

MICRO-ORGANISMS IN THEIR RELATION TO CHEMICAL CHANGE.[1]

ALMOST exactly on this day twenty-two years ago the subject of micro-organisms was introduced to the audience of the Royal Institution in one of those charming discourses, which so many of us well know were always to be heard from Dr. Tyndall. The title of his discourse on that occasion was "Dust and Disease," and its contents should be studied by all interested in this departure of science, forming, as it does, a part of the classical literature of the subject in which it marks the commencement of a new epoch.

It has probably rarely, if ever, happened before, that in so short a period as twenty-two years any science has undergone such a marvellous advance, such a many-sided development, as that which has taken place in the case of bacteriology, the science which is devoted to the study of those low forms of life which we group together under the name of *micro organisms*. This advance has been made through the ungrudging expenditure of self-denying labour by a great body of earnest workers of nearly every nationality. The subject is, indeed, one calculated to draw forth interest and enthusiasm, for the problems involved are not only of high scientific importance, but are also of incalculable moment to mankind, and, indeed, to the entire living creation.

The great impetus which this new science received at its outset was imparted by Pasteur, who has not only laid the foundations, but has also added, and is still adding, so much to the superstructure of its many mansions.

The side of bacteriology with which the general public is most commonly brought in contact is that which relates to disease, but of this I propose saying absolutely nothing to-night. It has been dealt with by others in this place, and notably by my friend Dr. Klein.

There is a second side of bacteriology which has also a special interest for at least a portion of the public, in consequence of the invaluable assistance which it has afforded to some sections of the industrial world. Indeed, chronologically, this industrial department of bacteriology was the first which claimed attention, for the growers of wine, the brewers of beer, and the manufacturers of fermented liquors of all kinds from the highest antiquity have been practical bacteriologists, of the same spontaneous order, it is true, as M. Jourdain was an unconscious author of prose. It was Pasteur also who first infused science into the operations of the wine-vat and the fermenting-tun, by his classical "Études sur la Bière et sur le Vin." It was he who first showed that the normal work of the brewery was accomplished by particular forms of micro-organisms, known as yeast, and that the frequent failures to produce beer or wine of the desired quality was occasioned by the presence of foreign forms of micro-organisms giving rise to acidity and other undesirable changes in these beverages.

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[1] Friday Evening Discourse, delivered by Prof. Percy F. Frankland F.R.S., at the Royal Institution of Great Britain, on February 19, 1892.

In these researches of Pasteur's on beer and wine, we are almost for the first time brought face to face with the precise nature of some of the chemical changes which micro-organisms bring about. The time-honoured vinous fermentation of sugar, the products of which had been valued and indulged in by man even from the days of Noah, is for the first time so accurately studied as to be definable almost with the precision of a chemical equation.

Similar attention was also given by Pasteur to some of the other micro-organisms which deteriorate the quality of the beer—thus more especially to the bacterium which causes the *acetic* or vinegar fermentation, which is a process of *oxidation*, transforming alcohol into vinegar; to the bacillus inducing the *lactic* fermentation, which is a process of *decomposition*, in which sugar yields lactic acid; as well as to that which brings about the *butyric* fermentation, a process of *reduction*, in which butyric acid is formed.

These are the foundations and scaffolding on which subsequent investigators of the phenomena of fermentation have laboured. Thus, making use of more refined methods than those which were at the disposal of Pasteur, Christian Hansen, of Copenhagen, has enormously extended our knowledge of the alcohol-producing organisms or yeasts; he has shown that there are a number of distinct forms, differing indeed but little amongst themselves in shape, but possessing very distinct properties, more especially in respect of the nature of certain minute quantities of secondary products to which they give rise, and which are highly important as giving particular characters to the beers produced. Hansen has shown how these various kinds of yeast may be grown or cultivated in a state of purity even on the industrial scale, and has in this manner revolutionized the practice of brewing on the Continent. For during the past few years these pure yeasts, each endowed with particular qualities, have been grown with scrupulous care in laboratories equipped expressly for this purpose, and these pure growths are thence despatched to breweries in all parts of the world, particular yeasts being provided for the production of particular varieties of beer. In this manner scientific accuracy and the certainty of success are introduced into an industry in which before much was a matter of chance, and in which nearly everything was subordinated to tradition and blind empiricism.

The Bacteria connected with the Soil.

It is, however, with regard to the bacteria connected with other industries than those of alcoholic fermentation that our knowledge has particularly advanced during the last few years. Thus some of the most important phenomena in agriculture have recently received a most remarkable elucidation through the study of bacteria.

Scientific agriculturists are generally agreed that one of the most important plant-foods in the soil is *nitric acid;* indeed they inform us that if a soil were utterly destitute of this material it would be incapable of growing the barest pretence of a crop, *either of corn, or of roots, or of grass*, even if the soil were in other respects of the most superb texture, however favourably it might be situated, however well drained, tilled, and supplied with the purely mineral ingredients of plant-food, such as *potash*, *lime*, and *phosphoric acid*.

Yet, notwithstanding the commanding importance of this substance nitric acid to vegetation, it is present in ordinary fertile soils in but little more than homœopathic doses.

These facts are gathered from those grand experiments which have during the past half-century been going on at Rothamsted under the direction of Sir John Lawes and Dr. Gilbert, and which have rendered the Hertfordshire farm a luminous centre of the whole agricultural world.

From these experiments it appears that sometimes there is in fertile soil under 1 part, and often under 10 parts, of nitrogen as nitrate per million of soil.

Indeed, in order to detect and estimate these minute quantities, the most refined methods of chemical analysis have to be called into requisition. [Demonstration of the presence of nitric acid in soil by diphenylamine test.]

Now the cause of such minute quantities only of nitric acid being found in soils is due partly to this material being washed away by the rain, and partly to its being so eagerly taken up by plants for the purposes of nutrition; for it has long been known that by suitable means the quantity can be enormously increased if no vegetation is maintained, and the ground properly protected from rain. The soil, in fact, under ordinary circumstances, continuously generates this nitric acid from the various nitrogenous manures which are applied to it, and it is in the form of nitric acid that the nitrogen of manures principally gains access as nutriment to the plant.

It was in the year 1877 that two French chemists, Schlœsing and Müntz, showed that this power of soils to convert the nitrogen of nitrogenous substances into nitric acid was due to low forms of life—to micro-organisms or bacteria. The proof which they furnished of this statement was of a very simple character, and consisted essentially in demonstrating that this production of nitric acid, or process of *nitrification*, as it is generally called, is promptly inhibited or brought to a standstill by all those materials which have the property of destroying micro-organisms, and which we call *antiseptics;* whilst similarly the process is stopped by heat and other influences which are known to be fatal to life in general.

These results of Schlœsing and Müntz were confirmed and greatly extended in this country by Mr. Warington and Dr. Munro, but although the vital nature of the process was fully established, little practical advance was until recently made in the identification or isolation of the particular bacteria responsible for this remarkable and invaluable transformation.

In 1886, however, a very important step was made by Dr. Munro, who showed that this process of nitrification could take place in solutions practically destitute of organic matter, or, in other words, that the vital activity of the bacteria of nitrification could be maintained without nutriment of an organic nature.

In 1885, I had myself already established the fact that some micro-organisms can actually undergo enormous multiplication in ordinary distilled water:—

Multiplication of Micro-organisms in Distilled Water.[1]

Hours after introduction of micro-organisms.	Number of micro-organisms found in 1 c.c. of water.
0	1,073
6	6,028
24	7,262
48	48,100

In taking up the subject of nitrification in conjunction with my wife in the autumn of 1886, I determined to avail myself of this remarkable property of the nitrifying organisms to grow in the absence of organic matter, thinking that in this way it would be possible to achieve a separation of the nitrifying organisms from other forms which can only grow if organic food materials are supplied to them.

Proceeding on these lines, we have carried on the process of nitrification over a period of upwards of four years without the nitrifying organisms being supplied with any organic food materials whatsoever:—

Composition of Solution employed for Nitrification.

Ammonium chloride	·5 grm.	In 1000 c.c. of distilled water.
Potassium phosphate	·1 ,,	
Magnesium sulphate	·02 ,,	
Calcium chloride	·01 ,,	
Calcium carbonate	5·0 ,,	

In a solution of this composition the process of nitrification was carried on over a period of upwards of four years, as indicated in the table on p. 137.

In carrying on this series of experiments it was soon evident that although a number of forms foreign to the nitrification process were being eliminated, there were still some remaining alongside of the nitrifying organisms, or, in other words, that a pure culture of the nitrifying organisms had not been obtained. From various considerations, however, we came to the conclusion that the nitrifying organisms probably differed from the other forms which were still present along with them in being unable to grow on the common cultivating medium employed by bacteriologists, and known as gelatin-peptone.

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[1] Proc. Roy. Soc., 188

Experiments on Continuous Nitrification in Mineral Solutions.

Generation	Date of inoculation.	Quantity taken for inoculation.	Date when nitrification first observed.
I.	9 5 1887	Original garden soil	20 5 1887
II.	25 6 1887	3 needle-loops from I.	30 6 1887
III.	1 7 1887	,, II.	7 7 1887
IV.	14 7 1887	,, III.	23 7 1887
V.	25 7 1887	,, IV.	17 8 1887
VI.	26 8 1887	,, V.	1 10 1887
VII.	3 10 1887	1 needle-loop from VI.	7 10 1887
VIII.	7 10 1887	1 needle-point from VII.	17 10 1887
IX.	17 10 1887	,, VIII.	29 10 1887
X.	7 11 1887	,, IX.	30 11 1887
XI.	1 12 1887	,, X.	15 12 1887
XII.	16 12 1887	,, XI.	13 1 1888
XIII.	28 1 1888	,, XII.	20 2 1888
XIV.	29 2 1888	,, XIII.	5 4 1888
XV.	7 4 1888	,, XIV.	27 4 1888
XVI.	30 4 1888	,, XV.	10 5 1888
XVII.	12 5 1888	,, XVI.	26 5 1888
XVIII.	19 7 1888	,, XVII.	3 9 1888
XIX.	3 9 1888	,, XVIII.	1 10 1888
XX.	11 10 1888	,, XIX.	20 11 1888
XXI.	24 11 1888	,, XX.	26 2 1889
XXII.	26 2 1889	,, XXI.	4 5 1889
XXIII.	28 6 1889	,, XXII.	18 10 1889
XXIV.	4 11 1889	,, XXIII.	17 12 1889
XXV.	27 12 1889	,, XXIV.	25 4 1890
XXVI.	16 5 1890	,, XXV.	2 7 1890
XXVII.	15 7 1890	,, XXVI.	30 1 1891
XXVIII.	3 3 1891	,, XXVII.	28 5 1891

The separation from these foreign forms was ultimately effected by enormously diluting one of these nitrifying solutions, and then taking out small portions of this diluted material and introducing each of these portions into separate ammoniacal solutions. In some of these nitrification was established, in others not, whilst amongst those in which nitrification *was* established, some contained organisms which grew upon gelatin, whilst one refused to give any growth on the gelatin at all, although it was seen under the microscope to contain abundantly bacteria of the form shown in the diagram. [Lantern-slide of nitrifying bacillococcus (Frankland).]

These results, which were published in March 1890, were followed in about a month by a communication in the *Annales de l'Institut Pasteur*, by M. Winogradsky, who had also separated a very similar, if not identical, nitrifying organism, and a few months later again a similar separation was made by Mr. Warington.

But these discoveries had not completely unravelled the problem of nitrification, for the organisms separated in these three independent investigations possessed only the property of *converting ammonia into nitrous and not into nitric acid.* The nitrous acid is an intermediate body, which curiously is rarely found excepting in very minute quantities in soil. The changes will be more clearly understood by reference to the chemical equations:—

$$(1)\quad \underset{\text{(Ammonia)}}{NH_3} + \underset{\text{(Oxygen)}}{3O} = \underset{\text{(Water)}}{H_2O} + \underset{\text{(Nitrous Acid)}}{NHO_2}$$

$$(2)\quad \underset{\text{(Nitrous Acid)}}{NHO_2} + O = \underset{\text{(Nitric Acid)}}{NHO_3}$$

The organisms separated by Winogradsky, by Warington, and by myself, possessed only the property of effecting the first of these changes, they were absolutely destitute of the power of bringing about the second.

Now, the curious thing is that the first of these changes is by far the most difficult to accomplish by *purely chemical means*, whilst the second can be brought about with the greatest facility. [Demonstration of addition of acid permanganate to solution of ammonium sulphate, colour not discharged.] [Demonstration of addition of acid permanganate to solution of potassium nitrite, colour discharged.]

Thus the potassium permanganate has no action on the ammonia, whilst the nitrite it oxidizes to nitrate.

In order to bring about the first change, we have to employ one of the most powerful oxidizing agents known to chemists, viz. ozone. [Demonstration: ozone from a Siemens tube was passed through strong solution of ammonia; the production of nitrous and nitric acids was exhibited by the formation of white fumes, as well as by the sulphanilic acid and diphenylamine tests.]

We thus see that the power of oxidation possessed by our nitrifying organism is altogether unique, and does not find its parallel amongst purely chemical agents of oxidation. *But how then is the nitric acid found in the soil produced, when these organisms yield only nitrous acid?*

At the time when I found that the organism which I had separated produced nitrous acid exclusively, I pointed out that it was doubtless explicable on one of two hypotheses: (1) that nitrous and nitric acids are produced by totally distinct organisms; or (2) that the same organism produces the one or the other according to the conditions under which it is growing.

More recent researches of Winogradsky have shown that the first of these two alternative hypotheses is the correct one, for, by making cultivations of soil in a solution containing nitrous acid and no ammonia, Winogradsky has succeeded in isolating a micro-organism which possesses the power of converting nitrous acid into nitric acid, but has no power of attacking ammonia. [Lantern-slide of nitric ferment (Winogradsky).]

This second organism or *nitric ferment*, as we may call it, resembles in its activity the purely chemical oxidizing agent—*potassium permanganate*—which, as we have seen, has no action on ammonia, but readily converts nitrous into nitric acid.

The process of nitrification in the soil now becomes intelligible in its entirety. It is the work of two independent organisms, the first of which converts ammonia into nitrous acid, whilst the second transforms into nitric acid the nitrous acid produced by the first.

There is a point in connection with the distribution of nitric acid in nature which is exceedingly remarkable, and which forces itself upon the attention of every student of the process of nitrification. Although nitric acid is generally so scantily present in the soil, there is one notable exception to this rule, for in the rainless districts of Chili and Peru there are found immense deposits of nitrate of soda, or Chili-saltpetre, as it is called, which would appear to represent the result of a gigantic nitrification process in some previous period of the earth's history. The vast quantities of this material which occur in these regions of South America can be gathered from the fact that its exportation has for years been going on at the rate indicated by the following figures:—During the first six months of 1890 there were brought to the United Kingdom 90,000 tons, and to the European continent 480,000 tons.

From the presence of such altogether enormous quantities, one is almost tempted to hazard the suggestion that in this particular region of the earth, under some special circumstances of which we know nothing, the nitrifying organisms must have been endowed then and there with very much greater powers than they possess to-day, and it is particularly noteworthy that in a recent examination of soils from nearly all parts of the earth, one coming from Quito, and therefore not far distant from these nitrate fields, was found to possess the power of nitrification in a degree far beyond that exhibited by any other soil hitherto experimented with. Is it not possible, perhaps, that we have in these vigorous nitrifying organisms of the soil of Quito, the not altogether unworthy descendants of the Cyclopean race of nitrifying bacteria, which must have built up the nitrate wealth of Chili and Peru, and thus countless ages ago founded the fortunes of our nitrate kings of to-day?

But these nitrifying organisms have also assisted in teaching us a highly important lesson in connection with the maintenance of life.

The facts which I have already referred to concerning the multiplication of micro-organisms in distilled water, and the continuation of the nitrification-process over a period of four years in purely mineral solutions, are strong presumptive evidence in favour of these bacteria being able to gain a livelihood in the entire absence of organic food-stuffs. I refrained, however, from promulgating such a revolutionary doctrine until I should have had an opportunity of repeating these experiments with materials in which the absence of even the merest traces of organic matter had been assured, for, as chemists well know, even distilled water may contain traces of organic matter.

Such a rigid proof as I had contemplated has, however, in the meantime been attempted by M. Winogradsky, also in connection with his experiments on nitrification, and he has indeed found that the nitrifying organisms flourish, multiply, and actually build up living protoplasm in a solution from which organic matter has been most rigorously excluded. Now this living protoplasm in the experiments in question must have been elaborated by these bacteria from carbonic acid as the source of the protoplasmic carbon, and from ammonia and nitrous or nitric acids as the source of the protoplasmic nitrogen. If these experiments are correct, and they were undoubtedly performed with great skill and much caution, they are subversive of one of the fundamental principles of vegetable physiology, which denies to all living structures, save those of green plants alone, the power of building up protoplasm from such simple materials.

I had occasion to mention in connection with these nitrifying organisms that they refuse to grow on the ordinary solid cultivating media employed by bacteriologists, a fact which presents a great obstacle to their isolation in a state of purity, for it is just by means of these solid culture media that micro-organisms are most easily obtained in the pure state.

This difficulty has, however, been overcome in a most ingenious manner, originally devised by Prof. Kühne, in which the solid medium is wholly composed of mineral ingredients, the jelly-like consistency being obtained by means of silica. [Demonstration of preparation of silica-jelly, consisting of ammonia sulphate, potassium phosphate, magnesium sulphate, calcium chloride, magnesium carbonate, and dialyzed silicic acid.]

Fixation of Free Nitrogen by Plants.

But whilst the study of the bacteria giving rise to nitrification has thus led to the subversion of what was regarded as a firmly established principle of vegetable physiology (viz. *the incapacity of any but green plants to utilize carbonic acid in the elaboration of protoplasm*), the same science has received another shock, of perhaps equal if not greater violence, through researches which have been carried on with other micro-organisms flourishing in the soil.

For nearly a century past agricultural chemists and vegetable physiologists have been debating as to whether the free nitrogen of our atmosphere can be assimilated or utilized as food by plants. This question was answered in the negative by Boussingault about fifty years since; the problem was again attacked by Lawes, Gilbert, and Pugh about thirty years ago, and *their* answer was also in the negative. In the course, however, of their continuous experiments on crops, Lawes and Gilbert have frequently pointed out that whilst the nitrogen in most crops can be accounted for by the combined nitrogen supplied to the land in the form of manures and in rain water, yet in particular *leguminous* crops, such as peas, beans, vetches, and the like, there is an excess of nitrogen which cannot be accounted for as being derived from these obvious sources. The origin of this excess of nitrogen in these particular crops they admitted could not be explained by any of the orthodox canons of the vegetable physiology of the time. The whole question of the fixation of atmospheric nitrogen by plants was again raised in 1876 by a very radical philosopher, in the person of M. Berthelot, whilst the most conclusive experiments were made on this subject by two German investigators, Prof. Hellriegel and Dr. Wilfarth, who have not only shown that this excess of nitrogen in leguminous crops is obtained from the atmosphere, but also that this assimilation of free nitrogen is dependent upon the presence of certain bacteria flourishing in and around the roots of these plants, for when these same plants are cultivated in sterile soil the fixation of atmospheric nitrogen does not take place. Moreover, the presence of these microbes in the soil occasions the formation of peculiar swellings or tuberosities on the roots of these plants, and these tuberosities, which are not formed in sterile soil, are found to be remarkably rich in nitrogen, and swarming with bacteria. [Lantern-slide of nodules on roots of sainfoin (Lawes and Gilbert).]

Extremely important and instructive in this respect are the experiments of Prof. Nobbe, who has not only confirmed the results mentioned, but has endeavoured to investigate the particular bacteria which bring about these important changes, and he has indeed succeeded in showing that in many cases each particular leguminous plant is provided with its particular micro-organism which leads to its fixation of free nitrogen. Thus he found that if pure cultivations of the bacteria obtained from a pea-tubercle were applied to a pea plant there was a more abundant fixation of atmospheric nitrogen by this pea-plant than if it was supplied with pure cultures of the microbes from the tubercles of a lupin or a robinia; whilst similarly the robinia was more beneficially affected by the application of pure cultures from robinia-tubercles than by those from either pea-tubercles or lupin-tubercles. [Lantern-slides exhibiting Nobbe's experiments on pea and robinia.]

This subject of the source of nitrogen in leguminous plants has again been taken up by Sir John Lawes and Dr. Gilbert at Rothamsted, and their recent results fully confirm the observations of these foreign investigators that it is partially derived from the free atmospheric nitrogen through the agency of bacteria in the soil.

To micro-organisms again, then, we must ascribe the accomplishment of this highly important chemical change going on in the soil, although it has not hitherto been so fully illuminated as the process of nitrification.

Selective Action of Micro-organisms.

Any of the ordinary plants and animals with which we are familiar may be regarded as analytical machines, and we ourselves, without any knowledge of chemistry, are constantly performing analytical tests; thus we can all distinguish between sugar and salt by the taste, between ammonia and vinegar by the smell, whilst by a more elaborate investigation we distinguish, for instance, between the milk supplied from two different dairies by ascertaining on which we or our children thrive best. In fact, such analytical or selective operations are amongst the first vital phenomena exhibited by an organism on coming into this world. It is, however, particularly surprising to find this analytic or distinguishing capacity developed in an extraordinarily high degree amongst micro-organisms. From the power which we have seen that some possess of flourishing on the extremely thin diet to be found in distilled water, we should be rather disposed to think that caprice would be the very last failing with which they would be chargeable. As a matter of fact, however, the perfectly unfathomable and inscrutable caprice of these minute creatures is amongst the first things with which the student of bacteriological phenomena becomes impressed. Let me call your attention to a striking example of this which I have recently investigated.

I have here two substances, which have the greatest similarity:—

	MANNITE.	DULCITE.
Occurrence.	Numerous plant-juices ...	Ditto, but less frequently.
Taste.	Sweet	Ditto, but less so.
Melts.	166° C.	188° C.
Crystalline form.	Large rhombic prisms	Large monoclinic prisms.

Not only, however, do these two substances possess such a strong external resemblance to each other, but in their chemical behaviour also they are so closely allied that one formula has to do duty for both of them, for so slight is the difference in the manner in which their component atoms are arranged that chemists have not yet been able with certainty to ascertain in what that difference consists. Under these circumstances it would have been anticipated that bacteria would be quite indifferent as to which of these two substances was presented to them, and that they would regard either both or neither as acceptable. But such is by no means the case; some micro-organisms, like ordinary yeast, have *no action upon either*, whilst *others will attack mannite, leaving dulcite untouched, others again, being less discriminating, attack both;* representatives of a fourth possible class *which would act upon dulcite but not upon mannite* are as yet undiscovered. [Lantern-slide and plate-culture of *B. ethaceticus.*]

This bacillus, I have recently shown, has the property of breaking down the mannite molecule into alcohol, acetic acid, carbonic anhydride, and hydrogen, but leaves the dulcite molecule untouched.

More recently I have, in conjunction with my late assistant, Mr. Frew, succeeded in obtaining a micro-organism which decomposes both mannite and dulcite into alcohol, acetic and succinic acids, carbonic anhydride, and hydrogen. [Lantern-slide and plate-culture of *B. ethacetosuccinicus.*]

Optically Active Substances.

But these are by no means the ultimate limits to which the selective or discriminating powers of micro-organisms can be pushed, for although mannite and dulcite are extremely similar substances, they are not chemically identical. We are acquainted, however, with substances which, though chemically identical, are different in respect of certain physical properties, and are hence known as *physical isomers*. It is in explanation of this physical isomerism that one of the most beautiful of chemical theories was propounded by Lebel and Van 't Hoff in 1874, and which remains unsupplanted to the present day.

This theory depends upon taking into consideration the dissymmetry of the molecule which is occasioned by the presence in it of a carbon-atom which is combined with four different atoms or groups of atoms, and is most easily intelligible from an inspection of these two models. [Demonstration of tetrahedral models of asymmetric carbon-atom.]

This molecular dissymmetry is specially exhibited in the crystalline form of such substances, and in their action upon polarized light.

The molecule arranged according to the one pattern has the property of turning the plane of polarization in one direction, whilst the molecule arranged according to the other pattern has invariably the property of turning the plane through precisely the same angle in the opposite direction. The molecular dissymmetry ceases when two such molecules combine together, the resulting molecule having no action on polarized light at all.

The interest of these phenomena in connection with micro-organisms lies in the fact that they are sometimes possessed of the power of discriminating between these physical isomers. Although this remarkable property was demonstrated years ago by Pasteur in respect of the tartaric acids, it has only comparatively rarely been taken advantage of. Recently, however, chemical science has been enriched in several instances by successfully directing the energies of micro-organisms in such work of discrimination.

During the past few years no chemical researches have commanded more interest, both on account of their theoretic importance and the fertility of resource exhibited in their execution, than those of Emil Fischer's, which have led to the artificial preparation in the laboratory of several of the various forms of sugar occurring in nature, as well as of other sugars not hitherto discovered amongst the products of the animal or vegetable kingdoms. The natural sugars are all of them bodies with dissymmetric molecules, powerfully affecting the beam of polarized light, but when prepared artificially they are without action on polarized light, because in the artificial product the left-handed and right-handed molecules are present in equal numbers, the molecules of the one neutralizing the molecules of the other, and thus giving rise to a mixture which does not affect the polarized beam either way. By the action of micro-organisms, however, on such an inactive mixture, the one set of molecules is searched out by the microbes and decomposed, leaving the other set of molecules untouched, and the latter now exhibit their specific action on polarized light, an active sugar being thus obtained.

The most suitable micro-organisms to let loose, so to speak, on such an inactive mixture of sugar-molecules, are those of brewers' yeast, which decompose the sugar molecules with formation of alcohol and carbonic anhydride. Their action on these inactive artificial sugars of Fischer's is particularly noteworthy.

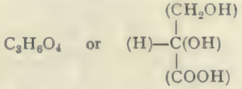
One of the principal artificial sugars prepared by Fischer is called *fructose*; it is inactive, but consists of an equal number of molecules of oppositely active sugars called *lævulose*.

One set of these lævulose-molecules turns the plane of polarization to the right, and we may call them *right-handed lævulose*, whilst the other set of *lævulose-molecules* turns the plane of polarization to the left, and we may call them *left-handed lævulose*.

The left-handed lævulose occurs in nature, whilst the right-handed lævulose, as far as we know, does not. Now, on putting brewers' yeast into a solution of the fructose, the yeast-organisms attack the left-handed lævulose molecules and convert them into alcohol and carbonic anhydride, whilst the right-handed lævulose is left undisturbed. The yeast organisms thus attack that particular form of lævulose of which their ancestors can have had experience in the past, whilst they leave untouched the right-handed lævulose molecules, which, being a new creation of the laboratory, they have no hereditary instinct or capacity to deal with.

This selective power is possessed also by other forms of micro-organisms besides the yeasts, which are indeed only suitable for the separatory decomposition of sugars, and by means of bacterial forms a much greater variety of substances can be attacked in this manner. Thus I have recently found that glyceric acid can be decomposed by the *B. ethaceticus*, to which I have already referred this evening.

This glyceric acid is thus represented by chemists:—



$$C_3H_6O_4 \quad \text{or} \quad \begin{array}{c} (CH_2OH) \\ | \\ (H)\text{—}C(OH) \\ | \\ (COOH) \end{array}$$

and this should, according to Le Bel and Van 't Hoff's theory, be capable of existing in two physically isomeric forms, as easily shown by our models.

The ordinary glyceric acid known to chemists is, however, quite inactive to polarized light, and must consist, therefore, of a combination in equal molecules of a right-handed and left-handed glyceric acid. Now when the *B. ethaceticus* is put into a suitable solution of the calcium salt of this glyceric acid, it multiplies abundantly, and completely consumes the right-handed molecules of the salt, but leaves the left-handed molecules entirely intact, a powerfully active glyceric acid being thus obtained. [Demonstration of the lævorotary power of solution of new zinc glycerate with projection-polariscope.]

A number of derivatives of this new active glyceric acid have recently been prepared in my laboratory:—

Derivatives of Active Glyceric Acid.

Formula.	Specific Rotation. $[\alpha]_D$
$(C_3H_5O_3)_2$ Ba + $2H_2O$	− 9°
$(C_3H_5O_3)_2$ Sr + $3H_2O$	− 10
$(C_3H_5O_3)_2$ Ca + $2H_2O$	− 12
$(C_3H_5O_3)_2$ Cd + $1\frac{1}{2}H_2O$	− 14
$(C_3H_5O_3)_2$ Zn + H_2O	− 22
$(C_3H_5O_3)_2$ Mg + H_2O	− 18·5
$C_3H_5O_3$ Na	− 16
$C_3H_5O_3$ Am	− 20
$C_3H_5O_3$ K	− 15
$C_3H_5O_3$ Li	− 20·5
$C_3H_5O_3$ Me	− 4·8
$C_3H_5O_3$ Et	− 9·2
$C_3H_5O_3$ Pr (*n*)	− 13·0

Here again, then, chemistry has been enriched by a number of new compounds, which we owe entirely to the unaccountable caprice of this micro-organism.

Individuality of Micro-organisms.

Although micro-organisms are thus becoming more and more indispensable reagents in the chemical laboratory, essential as they are for the production of many bodies, it is always necessary to bear in mind that by virtue of their vitality their nature is infinitely more complex than that of any inanimate chemicals which we are accustomed to employ. In a chemically pure substance we believe that one molecule is just like another, and hence we expect perfect uniformity of behaviour in the molecules of such a pure substance under prescribed conditions. In a pure cultivation of a particular species of micro-organism, however, we must not expect such rigid uniformity of behaviour from each of the individual organisms making up such a cultivation, for there may be and frequently are great differences amongst them; in fact, each member of such a pure culture is endowed with a more or less marked individuality of its own, and these possible variations have to be taken into consideration by those who wish to turn their energies to account. In fact, experimenting with micro-organisms partakes rather of the nature of legislating for a community than of directing the inanimate energies of chemical molecules. Thus frequently the past history of a group of micro-organisms has to be taken into account in dealing with them, for their tendencies may have become greatly modified by the experiences of their ancestors.

Of this I will give you an instance which has recently come under my observation:—

Here is a bacillus, which has the property of fermenting calcium citrate; I have found that it can go on exerting this power for years. On submitting this fermenting liquid to plate-cultivation, we obtain the appearances which you see here. [Lantern-demonstration of plate-culture of bacillus which ferments calcium citrate.]

If one of these colonies be transferred to a sterile solution of calcium citrate, it invariably fails to set up a fermentation of the latter, the bacillus having thus by mere passage through the gelatin-medium lost its power to produce this effect. If, however, we take another similar colony and put it into a solution of broth containing calcium citrate, fermentation takes place; on now inoculating from this to a weaker solution of broth containing calcium citrate, this also is put into fermentation, and by proceeding in this manner we may ultimately set up fermentation in a calcium citrate solution which absolutely refused to be fermented when the bacilli were taken directly from the gelatin-plate.

Phenomena of this kind clearly indicate that there may be around us numerous forms of micro-organisms of the potentiality of which we are still quite ignorant. Thus, if we were only acquainted with the bacilli I have just referred to from gelatin cultures, we should be quite unaware of their power to excite this fermentation of calcium citrate, which we have only been enabled to bring about by pursuing the complicated system of cultivation I have indicated. It is surely exceedingly probable, therefore, that many of the micro-organisms with which we are already acquainted may be possessed of numerous important properties which are lying dormant until brought into activity by suitable cultivation.

This power of modifying the characters of bacteria by cultivation is, I venture to think, of the highest importance in connection with the problems of evolution, for in these lowly forms of life, in which, under favourable circumstances, generation succeeds generation in a period of as little as 20 minutes, it should be possible through the agency of selection to effect metamorphoses, both of morphology and physiology, which would take ages in the case of more highly organized beings to bring about.

We hear much about the possibility of altering the human race through training from the enthusiastic apostles of education, but even the most sanguine cannot promise that any striking changes will be effected within several generations, so that such predictions cannot be tested until long after these reformers have passed away. In the case of micro-organisms, however, we can study the effect of educational systems consequentially pursued through thousands of generations within even that short span of life which is allotted to us here.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Peile, Master of Christ's College, has been re-elected Vice-Chancellor for the ensuing academical year.

The examination for the Diploma in Public Health will begin on October 4. Candidates are to send their names to the Registrary by September 27.

Prof. Roy announces a special course in Bacteriology, to be given during the long vacation by Mr. Adami, Mr. Kanthack (one of the Leprosy Commissioners), and Dr. Lloyd Jones, beginning on July 8. It is especially intended for candidates, not necessarily members of the University, for the Diploma in Public Health.

An elaborate scheme for the proposed Mechanical Sciences Tripos has been prepared by a special Syndicate, and appears in the *University Reporter* for May 31. The Tripos follows the main lines of the Natural Sciences Tripos, and seems to be free from the objections which have proved fatal to former schemes.

It is understood that the persons on whom honorary degrees are to be conferred on June 11, in connection with the Chancellor's inauguration, have been for the most part nominated by his Grace. This will perhaps account for the political character of the list, which is, however, partially relieved by the presence on it of General R. Strachey, and Mr. G. W. Hill, late of the office of the *American Ephemeris*, and known among astronomers for his fine work on the lunar theory. Five of the honorary graduates are Fellows of the Royal Society.

The University College of Wales, Aberystwyth, has been admitted to the privileges of a College affiliated to the University. The Mason College of Science, Birmingham, has been associated with the Local Lectures Syndicate in the work of University Extension.

Dr. W. Howship Dickinson, Dr. Bradbury, and Dr. J. F. Payne have been appointed Examiners in Medicine, Dr. W. S. Playfair and Dr. Griffith Examiners in Midwifery, and Messrs. Herbert Page, Frederick Treves, and Howard Marsh Examiners in Surgery.

Notice of opposition to the appointment of Sir R. S. Ball to the Directorship of the Observatory has been given. The grounds stated are that the duties of the Professorship of Geometry and Astronomy should occupy the whole time of the Professor, while the energies of the Director, in view of the recent developments of astronomical science, should be entirely devoted to the work of the Observatory. It is also held to be unwise in these circumstances to refuse the munificent offer of Mrs. Adams to provide £10,000 for the endowment of a separate Director.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 19.—"On the Changes produced by Magnetization in the Length of Iron and other Wires carrying Currents." By Shelford Bidwell, M.A., LL.B., F.R.S.

The changes of length attending the magnetization of rods or wires of iron and other magnetic metals which were first noticed by Joule in 1841, and have in recent years formed the subject of many experiments by the author, have been found to be related to several other phenomena of magnetism. Maxwell has suggested that they sufficiently account for the twist which is produced in an iron wire when magnetized circularly and longitudinally at the same time. The resultant lines of magnetization, as he points out, take a spiral form; the iron expands in the direction of the lines of magnetization, and thus the wire becomes twisted. Prof. G. Wiedemann, however, to whom the discovery of the magnetic twist is due, appears not to be satisfied with this explanation, believing the effect to be caused by unequal molecular friction.

The subject of magnetic twists has been very fully and carefully investigated by Prof. C. G. Knott, and in a paper published last year in the Transactions of the Royal Society of Edinburgh (vol. xxxvi., Part II., p. 485) he indicates many details in which the phenomena of twist closely correspond with those of elongation and retraction. Assuming their essential identity, and noting that "an increased current along the wire affects the points of vanishing twist in a manner opposite to that in which an increased tension affects it," Prof. Knott is "inclined to conclude that the pure strain effects of these influences are of an opposite character." Now, since the magnetic elongation of an iron wire is known to be diminished by tension, the remark above quoted amounts to a prediction that in an iron wire carrying a current the magnetic elongation would be increased. "We know nothing so far," Prof. Knott observes, "regarding the changes of length when an iron wire *carrying a current* is subjected to longitudinal magnetizing forces"; and it was with the object of acquiring some information on this point, and testing Prof. Knott's prediction, that the experiments described in the present paper were undertaken. The results show that it was amply verified, and thus Maxwell's explanation of the twist receives still further corroboration.

The apparatus used and the methods of observation were the same as those described in former papers. Each specimen of wire examined was 10 cm. long, and the indications of the instrument were read to one ten-millionth part of the length.

The wire first used was of soft commercial annealed iron, 0·75 mm. in diameter. The changes of length which it exhibited under the influence of magnetizing forces gradually increased from 13 to 315 C.G.S. units are indicated in the second column of Table I., in which the unit is one-millionth of a centimetre or one ten-millionth of the effective length of the wire.

The experiment described in the last paragraph was repeated while a current of 1 ampere was passing through the wire, the several magnetizing forces employed being made as nearly as possible the same as before by inserting the same resistances successively in the circuit. The results appear in the third column of Table I., and show that the maximum elongation had risen from 11·5 to 14·5 ten-millionths, while the decrement in a field of 315 had fallen from 22·5 to about 17·5.

The current through the iron wire was then increased, by an alteration of the rheostat, to 2 amperes, and, as appears in the last column of the table, there was again a marked increase of the maximum elongation, and decrease of the retraction in a field of 315.

TABLE I.—*Iron Wire, diameter* 0·75 *mm.*

Magnetic field due to coil. C.G.S. units.	Elongations in ten-millionths of lengths.		
	With no current through wire.	With 1 ampere through wire.	With 2 amperes through wire.
13	3	7	
16	6	9	11·5
23	7·5	12	
34	10	14·5	20
40	11·5	14	
50	10	14	20
61	9·5	12	
81	6	9·5	16
97	4	8	
130	0	3·5	8
171	−4	0	
202	9	4	−1
244	13·5		
250	—	−9	−5
315	−22·5		
319	—	18·5	
323	—		−13

For the sake of easy comparison, the principal results obtained with this wire are collected in Table II.

TABLE II.—*Iron Wire, diameter* 0·75 *mm.*

Current through iron wire. Amperes.	Maximum elongation in ten-millionths of length.	Retraction in field of 315 C.G.S. units.	Field in which length is unchanged.
0	11·5	22·5	130
1	14·5	17·5	170
2	20	12	200

Similar experiments were afterwards made with nickel and cobalt.

A nickel wire was used, the diameter of which was 0·65 mm. The retractions which it underwent in fields of gradually increasing strength are given in the second column of Table III.

TABLE III.—*Nickel Wire, diameter* 0·65 *mm.*

Magnetic field due to coil. C.G.S. units.	Retractions in ten-millionths of length.		
	With no current through wire.	With 1 ampere through wire.	Difference.
12	8	8	0
15	10	11	−1
19	15	15	0
28	25·5	25	0·5
36	34	33	1
50	50	48	2
69	74	72	2
84	92	92	0
99	113	112	1
119	134	133	1
150	164	162	2
175	178	178	0
209	196	194	2
256	217	215	2
330	241	240	1

The retractions of the wire when carrying a current of 1 ampere, are given in the third column of the table. Remembering that the figures in the second and third columns denote millionths of a centimetre, the close agreement between the two is very remarkable. Such small discrepancies as exist can hardly be entirely accounted for by observational or instrumental errors; they are probably mainly due to the effect of the rise of temperature (2°·6 C.) caused by the current in diminishing the susceptibility of the nickel.

Tension has a large effect upon the magnetic retraction of nickel: it is, therefore, the more remarkable that the action of a current, which operates so markedly upon iron, should in nickel be practically insensible.

The results with no current obtained for a strip of rolled cobalt, the length of which between the clamps was 10 cm., and the cross section 1·82 sq. mm., are given in the first two columns of Table IV., and those with a current of 2 amperes in the third column.

TABLE IV.—*Cobalt Strip, section* 1·82 *sq. mm.*

Magnetic field due to coil. C.G.S. units.	Retraction in ten-millionths of length.		
	With no current through strip.	With 2 amperes through strip.	Difference.
34	1	1	0
50	2	2·5	−0·5
84	4	5	−1
100	6	6	0
119	7·5	8·5	−1
153	11	11·5	−0·5
209	16	16·5	−0·5
331	26	27·5	−1·5

From an inspection of the differences tabulated in the fourth column, it appears that the effect of the current is to increase the retraction very slightly.

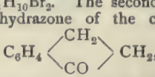
According to Rowland the susceptibility of cobalt is *increased* by heating. The small additional retraction indicated when the current was passing was, therefore, no doubt due to the increased susceptibility consequent upon current heating. It may be noted that tension seems to have no material effect upon the magnetic retraction of cobalt.

Summary.

In an iron wire carrying a current, the maximum magnetic elongation is greater, and the retraction in strong fields is less, than when no current is passing. The effect of the current is opposite to that of tension.

The magnetic retractions of nickel and of cobalt are not sensibly affected by the passage of a current through the metals. (Tension considerably modifies the magnetic retraction of nickel, but not that of cobalt.)

"The Human Sacrum." By A. M. Paterson, M.D., Professor of Anatomy in University College, Dundee, St. Andrews University. Communicated by Prof. D. J. Cunningham, D.Sc., F.R.S.

Chemical Society, May 19.—Prof. A. Crum Brown, F.R.S., President, in the chair.—The President announced that the Council had adopted a resolution expressive of the loss the Society and chemists generally had suffered by the death, on May 5, of Prof. von Hofmann. The resolution would be communicated to the family of the deceased, and to the German Chemical Society.—The following papers were read:—The magnetic rotation of compounds supposed to contain acetyl, or of ketonic origin, by W. H. Perkin. The author draws attention to Brühl's determination of the refractive powers of ethyl acetoacetate, which favours a ketonic constitution, and to its magnetic rotation, which was determined some years ago by himself, and which also supports this view. A list is then given of seven supposed acetyl compounds, of which he has ascertained the magnetic rotation, all giving numbers pointing to a ketonic constitution. As such compounds as these behave sometimes as ketonic and sometimes as hydroxy-derivatives, it was thought desirable to examine a larger number of compounds supposed to contain acetyl, or of ketonic origin, between wide limits of temperature. The following were selected: pyruvic acid, levulinic acid (fused and in solution), ethyl acetonedicarboxylate, ethyl acetoacetate, acetylacetone, methylacetylacetone, and ethyl β-amidocrotonate. The last-mentioned four were examined at widely different temperatures. The magnetic rotations of the first five substances agree with a ketonic constitution, though that obtained for ethyl acetonedicarboxylate is rather high. The rotation of acetylacetone is very high, showing it to be an unsaturated or hydroxy-compound, whilst the value obtained for methylacetylacetone stands between the hydroxy and ketonic rotations. At temperatures near 100°, however, these compounds give much lower rotations than when cold, showing apparently that they change into the more stable or ketonic form when heated. The refractive and dispersive powers of these compounds confirm the magnetic rotations. The magnetic rotation and the refractive and dispersive powers of ethyl β-amidocrotonate show it to be an unsaturated compound.—The origin of colour: ii. The constitution of coloured nitro-compounds, by H. E. Armstrong. The author has previously maintained that colour is conditioned by a quinonoid structure in the case of azo-dyes, such as the rosanilines, methylene-blue, &c. This view is clearly seen to be recommending itself to chemists. Nietzki makes reference to the quinonoid character of a number of dye-stuffs, although he does not seek to apply such a view at all generally. The author considers that, in the case of coloured compounds which have been fairly well studied, it is so generally true that a quinonoid formula is applicable, that the reconsideration of the formula of any coloured substance is warrantable if it do not come within the rule. The term "quinonoid" must, however, be understood to include compounds of the type of benzil, and in the case of closed chain compounds, it appears to be essential that at least one of the quinonoid carbon atoms be associated with a dyad radicle, and that the ring itself be unsaturated. The presence of two ortho- or para-carbonyl groups in a saturated ring apparently does not condition colour. Nitro-compounds as a class do not come within the suggested colour-rule. It is well-known, however, that nitro-compounds are not all coloured, many which are commonly described as yellow, being obtained white if prepared with care; from this it follows that the nitro-group does not *per se* condition colour. This is confirmed by a comparison of ortho- and para-nitrophenol. The ortho-compound is intensely yellow, very volatile, and insoluble in water; paranitrophenol is colourless, non-volatile with steam, and fairly soluble in water. Such a difference as this can hardly be ascribed to a mere change in the relative positions of the radicles. The difference is rendered all the more striking when the substances are contrasted with the methoxy-compounds prepared from ortho- and para-nitrophenol. These two substances are colourless, and agree as closely in their general properties as do most isomeric compounds containing the same radicles. It therefore appears justifiable to represent orthonitrophenol by a quinonoid formula—$C_6H_4 : O . NO_2H$, and to term it quinoneorthonitroxime. As only para- and ortho-compounds can have quinonoid formulæ, it would follow that metanitro-derivatives must be colourless; actually, however, metanitraniline has an intense yellow colour, but gives a colourless benzoate. The present view of its constitution therefore requires revision.—The origin of colour. iii. Colour as an evidence of isodynamic change: the existence of isodynamic acids, by H. E. Armstrong. The author applies the colour-rule dwelt on in the preceding paper to the cases of the coloured substances known as paradihydroxyterephthalic acid, dihydroxypyromellithic acid, and the corresponding "diamido" acids. These may be represented as quinonoid compounds, thereby accounting for their being coloured. Such substances as these readily change in type, yielding derivatives which may be colourless owing to conversion into an isodynamic form.—Studies on isomeric change, No. iv: Halogen derivatives of quinone, Part i., by A. R. Ling. Paradichloroquinone on bromination does not yield metadichlorodibromoquinone, as stated by Hantzsch and Schniter, but the normal product, paradichlorodibromoquinone. Contrary to the statement of Levy, this latter substance does not furnish chlorobromanilic acid on treatment with alkali, but a compound of one molecular proportion of chloranilate and two of bromanilate. Metadichloroquinone on bromination at a high temperature yields paradichlorodibromoquinone, but at ordinary temperatures the normal product, metadichlorodibromoquinone is chiefly obtained. A number of new compounds are described.—Halogen derivatives of quinone, Part ii., by A. R. Ling and J. L. Baker. Chlorotribromoquinone is prepared by brominating monochloroquinol and subsequently oxidizing the product. On treatment with alkali, it generally yields a molecular compound of the composition $C_6ClBr(ONa)_2O_2,2C_6Br_2(ONa)_2O_2$; $12H_2O$. Trichlorobromoquinone is obtained by brominating trichloroquinone. On treatment with soda, it yields the compound $C_6Cl_2(ONa)_2O_2$, $2C_6ClBr(ONa)_2O_2$; $10\frac{1}{2}H_2O$.—The crystalline forms of the sodium salts of substituted anilic acids, by W. J. Pope. A comparison of the crystallographic dimensions of the sodium salts of the brominated and chlorinated anilic acids referred to in the two preceding papers shows that the crystals possess considerable similarity.—Formation of a hydrocarbon, $C_{18}H_{12}$, from phenylpropionic acid, by F. S. Kipping. When phenylpropionic acid is treated with phosphoric anhydride, a resinous mass is obtained which contains at least three products. The first of these is a hydrocarbon, $C_{18}H_{12}$, which is oxidized by chromic acid mixture to a quinone, $C_{18}H_{10}O_2$. The hydrocarbon yields a dibromo-derivative, $C_{18}H_{10}Br_2$. The second product is a substance which yields a hydrazone of the composition $C_{15}H_{14}N_2$. It may possibly be  $C_6H_4 \left\langle \begin{matrix} CH_2 \\ CO \end{matrix} \right\rangle CH_2$, owing to the fact that it seems to be formed on treating phenylpropionic chloride with aluminium chloride. The third substance produced seems to be an organic derivative of phosphoric acid.—Metallic derivatives of acetylene, by R. T. Plimpton. The silver compounds of acetylene, obtained by several methods, viz. by precipitation of silver acetate or ammoniacal silver nitrate solutions with acetylene, on analysis gave numbers lying between those required for $C_2Ag_2,\frac{1}{2}H_2O$, and $C_2Ag_2.\frac{1}{3}H_2O$. Aqueous or alcoholic silver nitrate solutions yield precipitates varying in composition from $3C_2Ag_2,2AgNO_3,H_2O$, and $C_2Ag_2,2AgNO_3,H_2O$. Silver sulphate solutions gave a product of the composition $2C_2Ag_2,Ag_2SO_4,H_2O$. Mercuric acetate solution gives a white precipitate with acetylene, of the composition $3HgO,2C_2H_2$, which is not explosive, and does not yield acetylene when treated with hydrochloric acid. In these two properties this substance differs from the precipitate obtained from mercurous acetate.—Isomerism amongst the substituted thioureas, by A. E. Dixon. The author has prepared and examined the properties of isomerides of methylphenylbenzylthiourea and dimethylphenylthiourea.—Note on diastatic action, by E. R. Moritz and T. A. Glendinning. The authors draw the following conclusions from a series of experiments on diastatic action. The attainment of a resting stage in the transformation of starch by diastase by no means shows that the energy of the diastase is exhausted. The energy of the "residual" diastase is, in fact, very considerable, but it is lessened to a marked extent by subjecting the diastase for some time to a temperature exceeding the optimum one for saccharification. When, however, it is not exposed for any length of time to a temperature exceeding the optimum, it appears capable, after transforming a considerable amount of starch, of transforming further quantities to nearly the same point, when such further quantities are added successively and subsequent to the attainment of the resting stage in the preceding transformation.

Zoological Society, May 17.—Prof. W. H. Flower, F.R.S., President, in the chair.—Mr. W. T. Blanford, F.R.S., exhibited and made remarks on the skin of a Wild Camel obtained by Major C. S. Cumberland in Eastern Turkestan.—In a paper on the geographical distribution of the Land-Mollusca of the Philippine Islands, the Rev. A. H. Cooke showed that the distribution of the different subgenera of *Cochlostyla* affords an interesting clue to the early relations of the various islands of the Philippine group. Regarded from this point of view, the central islands, Samar, Leyte, Bohol, Cebu, Negros, and Panay, with Luzon, were closely related, while Mindoro and Mindanao were remarkably isolated even from their nearest neighbours. An examination of the intervening seas accounted for these phenomena, the depths between the central islands being inconsiderable, while Mindoro and Mindanao are surrounded by very deep water. The Mollusca of the two ridges between the Philippines and Borneo, formed by Busuanga, Palawan, and Balabac, and by the Sulu Archipelago, were partly Philippine, partly Indo-Malay. Two remarkable groups of *Helix*, peculiar to Mindoro, Busuanga, and Palawan, showed relations with Celebes and possibly with New Guinea. The Mollusca of the Batan, Tular, and Talantse Islands were also discussed. Regarded as a whole, the Land-Mollusca of the Philippines were stated to contain: (1) Indo-Malay, (2) Polynesian, (3) indigenous elements, the first decidedly predominating.—A communication was read from Graf Hans von Berlepsch, and M. Jean Stolzmann, containing an account of a collection of birds made by M. Jean Kalinowski in the vicinity of Lima and Ica, in Western Peru. The species of which examples were obtained in the localities were eighty in number. In an appendix an account of previous authorities on the same subject was added.—Mr. G. A. Boulenger gave an account of *Lucioperca marina*, a rare species of fish, originally described by Pallas from the Black Sea and the Caspian, and little known of late years.—A communication from Mr. Oldfield Thomas contained a revision of the Antelopes of the genus *Cephalolophus*, of which eighteen species were recognized as valid. A new species was described as *Cephalolophus jentincki*, from Liberia.—Prof. Bell called attention to the remarkable amount of variation presented by *Pontaster tenuispinis*, numerous examples of which he had been able to examine and compare. He came to the conclusion that several North-Atlantic species, which had been described as distinct, should be regarded as belonging to it.—A communication was read from Mr. H. H. Druce giving an account of the Butterflies of the family Lycænidæ, of the South Pacific Islands. Of thirty-one species mentioned, seven were described as new to science.

Linnean Society, May 24.—Anniversary Meeting.—Prof. Stewart, President, in the chair.—The Treasurer presented his annual report duly audited, and the Secretary having announced the elections and deaths during the past twelve months, the usual ballot took place for new members of Council, when the following were elected: Messrs. E. L. Batters, William Carruthers, Herbert Druce, Spencer Moore, and Dr. D. H. Scott. The President and officers were re-elected. The Librarian's report having been read, and certain formal business having been transacted, the President delivered his annual address, taking for his subject "Commensalism and Symbiosis." On the motion of Dr. R. C. A. Prior, seconded by Mr. Jenner Weir, a cordial vote of thanks was accorded to the President for his able address, with a request that he would allow it to be printed.—The Society's Gold Medal was then formally presented to Dr. Alfred Russel Wallace in recognition of the service rendered by him to zoological science by numerous valuable publications. After Dr. Wallace had replied, the President announced the gift by Dr. R. C. A. Prior of an oxyhydrogen lantern for use at the evening meetings, and moved a vote of thanks to him for his valuable donation. This having been carried by acclamation, the proceedings terminated.

CAMBRIDGE.

Philosophical Society, May 2.—Prof. G. H. Darwin, President, in the chair.—The following communication was made:—Note on the application of the spherometer to surfaces not spherical, by Mr. J. Larmor. The ordinary form of spherometer, with equilateral triangular frame, gives a definite reading, when applied to a surface of double curvature, which corresponds to the arithmetic mean of the principal curvatures at the point; thus on a cylinder it will indicate half the curvature. It may be modified in various ways so as to measure both the principal curvatures by two observations.

May 16.—Prof. G. H. Darwin, President, in the chair.—The following communications were made:—Recent advances in astronomy with photographic illustrations, by Mr. H. F. Newall. A series of photographs was exhibited by the lantern and described, to illustrate recent progress in astronomical photography. The series included some interesting specimens taken with the Newall telescope, in which the object-glass is not specially corrected for photographic purposes.—On the pressure at which the electric strength of a gas is a minimum, by Prof. J. J. Thomson. The author showed that when no electrodes are present, the discharge passes through air at a pressure somewhat less than that due to 1/250 mm. of mercury; the discharge passes with greater ease than it does at either a higher or a lower pressure. Mr. Peace has lately shown that when electrodes are used, the critical pressure may be as high as that due to 250 mm. of mercury; so that as the spark length is altered the critical pressure may range from 250 mm. to 1/250 of a mm. It was pointed out that this involved the possession by a gas conveying the discharge of a structure much coarser than any recognized by the kinetic theory of gases. The author suggested a theory of such a structure, and showed that the theory would account for the influence of spark length and pressure on the potential difference required to produce discharge.—On a compound magnetometer for testing the magnetic properties of iron and steel, by Mr. G. F. C. Searle. An aluminium wire, 30 inches long, suspended vertically by a fibre, carries at the top a magnet fixed at right angles to the wire. The lower end carries a light fork across which a fibre is stretched horizontally. A mirror attached to this fibre carries a magnet at right angles to the fibre. The mirror is thus capable of two independent motions. The specimen of iron is placed in a magnetizing coil near the mirror, and the magnetizing current passes also round a coil placed near the upper magnet. The motion of the mirror is observed by the aid of a spot of light. On gradually increasing and diminishing the current, the spot traces out the well-known hysteresis curves.

EDINBURGH.

Royal Society, May 16.—Sir Douglas Maclagan, President, in the chair.—The Astronomer-Royal for Scotland exhibited a stellar photograph, by Dr. Gill, of the Cape Observatory.—Dr. W. Peddie read a note on the law of transformation of energy and its applications. A generalization of the second law, applicable to forms of energy other than heat, was shown, by special examples, to lead to results already deduced by other methods.—Dr. C. G. Knott and Mr. A. Shand communicated a short note on the volume-effects of magnetization, which was supplementary to results communicated to the Society last year by the former author. When a particular size of iron tube was magnetized, the internal volume was found to undergo the following remarkable series of changes. In very weak fields there was first a slight increase, which, as the field was made stronger, passed through a maximum, then vanished and finally changed sign. From this point (about field 20) up to a field of 120 there was diminution of volume. This diminution was greatest in a field of 64. In fields higher than 120 there was again increase of volume, which attained a maximum about field 400, and fell off very slowly in higher fields. This curious variation of cubical dilatation with strength of field was shown to imply a transverse linear dilatation of (in general) opposite sign to the well-known longitudinal linear dilatation. The amounts, the positions of the maximum points, and of the vanishing points, of these correlated linear dilatations differed sufficiently in detail to produce this peculiar repeated change of sign in the cubical dilatation.—Dr. Hunter Stewart read a paper on the ventilation of schools and public buildings. The first part of the paper contained an account of an investigation as to the presence of organic nitrogenous matter in expired air. Several methods were used for absorbing and collecting these products, *e.g.* breathing through strong sulphuric acid, condensing the moisture from the breath, &c. The organic matter was determined by the process of Kjeldahl, by which the nitrogen is converted into ammonia. The results showed that each cubic foot of expired air contained on an average 0·01149 milligrams of ammonia as such, and 0·002 milligrams of ammonia derived from organic matter. The water condensed from 10 cubic feet of expired air contained on an average 0·5 milligrams of solid residue which entirely disappeared on ignition. These results, confirmatory of the observations of Hermann and Lehmann, proved that the organic matter in badly ventilated rooms did not come from the breath, but from the skin and clothing of the occupants. Since this must be variable, depending on obvious conditions, Dr. Stewart did not determine it, but relied on the estimation of the carbonic acid and moisture as a measure of the efficiency of the ventilation. The following are some of his results taken as averages:—

Edinburgh Hospitals, with 2000 cubic feet of space per bed—				
	Day	5·5 c.c. CO_2 per 10,000		
	Night	5·85	,,	,,
Churches	Highest	63·5	,,	,,
	Lowest	20·0	,,	,,
Schools, with, per child,				
	154 c. ft. space and 9·8 sq. ft. area	9·9	,,	,,
	141 ,, ,, 8·8 ,,	13·3	,,	,,
	116 ,, ,, 7·1 ,,	17·2	,,	,,

All the schools and churches were without mechanical ventilation.—Prof. James Geikie read a paper on the glacial succession in Europe. The deposits which first give evidence of glacial action are generally referred to the Pliocene period. These are the oldest ground moraines of Central Europe, the ground moraine underlying the "lower diluvium" of Sweden, and the deposits of the Weybourne Crag with their Arctic marine fauna. Genial climatic conditions followed this period, with a wide land area, Britain being joined to the continent. Then followed the epoch of maximum glaciation, the Scottish and Scandinavian ice-sheets being continuous. Genial climatic conditions followed, Britain being again continental. Then submergence ensued to the 500-feet level, followed by another glacial epoch in which the Scottish and Scandinavian ice-sheets were again continuous. This was succeeded by genial conditions, Britain being once more joined to the continent. Submergence to the 100-feet level in Scotland followed, and then came Arctic conditions with local ice-sheets, succeeded by temperate conditions and the wide land area, and subsequently by submergence to the 50-feet level. Another cold period followed with local glaciers—the last in Britain.

Paris.

Academy of Sciences, May 30.—M. d'Abbadie in the chair.—Introduction of M. Guyon, the new member elected in the place of M. Richet.—Observations of the small planets, made with the great meridian instrument of the Paris Observatory during the second and third quarters of the year 1891, by M. Mouchez.—On the propagation of electrical oscillations, by M. H. Poincaré. The disturbance is supposed to be propagated along a thin straight conductor. The enfeeblement of the disturbance is theoretically shown to vanish when the diameter of the conductor becomes indefinitely small.—Another blow to the ascent theory of cyclones, by M. Faye. A discussion of recent observations, showing that cyclones are not produced by convection from the soil, but by disturbances in the general circulation of air in the higher regions.—On the monkey of Montsaunès discovered by M. Harlé, by M. Albert Gaudry. A portion of the mandible of a monkey, containing three teeth, was exhibited, found by M. Harlé, engineer at Toulouse, in the Quaternary of the Haute-Garonne. It shows the greatest similarity with the magot of Gibraltar and Algiers.—Physiological effects of a liquid extracted from the sexual glands, and especially the testicles, by M. Brown-Séquard.—On the relations of the Devonian and Carboniferous formations of Visé, by M. J. Gosselet.—Study of the physical and chemical phenomena under the influence of very low temperatures, by M. Raoul Pictet. The calorific æther waves corresponding to low temperatures are found to traverse all bodies with hardly any resistance. A test-tube filled with chloroform was placed in a nitrous oxide refrigerator at -120°. A thermometer in the tube showed a gradual fall to $-68^\circ\cdot5$, when crystallization commenced. On removing the test-tube to a refrigerator at -80°, the temperature indicated by the thermometer *fell rapidly* from $-68^\circ\cdot5$ to -80°, while the crystals formed on the walls of the test-tube fused and disappeared. On replacing it into the -120° refrigerator, the temperature rose to $-68^\circ\cdot5$, and the crystals reappeared. M. Pictet explains these extraordinary phenomena by supposing his thermometers to have acted more as thermodynamometers than as thermoscopes. While the crystals were forming in the first refrigerator, the radiation from the bulb was neutralized by the latent heat given out by the chloroform in crystallizing, whereas in the warmer refrigerator the crystals did not form, and radiation alone was active. Alcohol and sulphuric ether thermometers were used, which were checked by thermometers containing dry hydrogen at four different pressures.—On rectangular co-ordinates, by M. Hatt.—On the application of the optical properties of minerals to the study of the inclosures in volcanic rocks, by M. A. Lacroix.—On a property common to three groups of two polygons, inscribed, circumscribed, or conjugate to the same conic, by M. Paul Serret.—On the canonical developments in series the coefficients of which are differential invariants of a continuous group, by M. Arthur Tresse.—On the calculation of the coefficient of resistance of air, supposing the resistance proportional to the fourth power of the velocity, by M. de Sparre.—On a means of bringing two non-miscible liquids into intimate contact in definite proportions, by M. Paul Marix. This is done by pouring both liquids into the same vessel at a definite rate, and allowing them to leave it by an orifice in the side. They will escape together in the proportion of their volumes, if the level of the liquid is maintained uniform by a constant supply. The surface of separation is invariably found at the level of the orifice, and if a flattened spout is used, a lamellar arrangement of the liquids is produced, thus giving a large surface of contact.—On a hydro-silicate of cadmium, by MM. G. Rousseau and G. Tite. This is produced by the action of the glass vessel when the solid hydrate of neutral cadmium nitrate is heated to about 300°. On dissolving away the basic nitrate with boiling alcohol, the silicate can be detached from the glass in long scales by hot water. Its formula is $2(CdO, SiO_2) . 3H_2O$.—On the decomposition by heat of ammoniacal pentachloride of phosphorus, nitrochloride of phosphorus, and phosphame, by M. A. Besson.—On the phosphates of strontium, by M. L. Barthe.—The calorific power of pit-coal and the formulæ by means of which its determination is attempted, by M. Scheurer-Kestner.—Mechanical determination of the boiling-points of terminal complex substitution products, by M. G. Hinrichs.—On some reactions of the three amido-benzoic acids, by M. Œchsner de Coninck.—On the composition of chlorocruorine, by M. A. B. Griffiths.—On the antiseptic properties of formaldehyde, by M. A. Trillat.—The nervous system of the Neritidæ, by M. E. L. Bouvier.—On the osteological characters of a male *Mesoplodon Sowerbyensis* recently stranded on the French coast, by M. P. Fischer.—On a new species of *Gammarus* of the Lac d'Annecy, and on the fresh-water Amphipoda of France, by MM. E. Chevreux and J. de Guerne.—Action of various toxic substances on *Bombyx Mori*, by M. J. Raulin.—On the genetic relations of resinous and tannic substances of vegetable origin, by MM. Edouard Heckel and Fr. Schlagdenhauffen.—Researches on the grafting of Crucifers, by M. Lucien Daniel.—Contribution to the study of the toxic effect of the diphtheria bacillus, by M. Guinochet.—Contribution to the knowledge of the Saharian climate, by M. Georges Rolland. A summary of observations made at a meteorological station in the oasis of Ayata, in Southern Algiers. The sparse vegetation found here and there seems to derive its moisture from subterranean sources, whence it ascends by capillary attraction, and from certain deliquescent salts found in the soil which absorb moisture at night.—On a passage in Strabo relating to a treatment of the vine, by M. Ant. Aublez.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—La Distribution de L'Électricité, *Usines Centrales*: R. V. Picou (Paris, Gauthier-Villars) —Travail des Bois: M. Alheilig (Paris, Gauthier-Villars).—Medical Electricity: Drs. Steavenson and Jones (Lewis).—First Report of the U.S. Board on Geographic Names, 1890–91 (Washington).—Smithsonian Report, 1890 (Washington).—Lehrbuch der Zoologie: Dr. R. Hertwig, 2 vols. (Jena, Fischer).—Ziele und Wege Biologischer Forschung: Dr. F. Dreyer (Jena, Fischer).—Key to Arithmetic for Beginners: J. Brooksmith and E. J. Brooksmith (Macmillan).—Transactions of the Sanitary Institute, vol. xii. (Stanford).—Bibliography of the Algonquian Languages: J. A. Pilling (Washington).—A Monograph of the Myxogastres: G. Massee (Methuen).—Popular Readings in Science: J. Gall and D. Robertson (Constable).—Researches on Micro-Organisms, Dr. A. B. Griffiths (Baillière).—Darwin et ses Précurseurs Français, deux. édtn., A. de Quatrefages (Paris, Alcan).—Trattato di Fisico-Chimico secondo la Teoria Dinamica: E. dal Pozzo di Mombello (Milano).

Pamphlets.—The Orthoceratidæ of the Trenton Limestone of the Winnipeg Basin: J. F. Whiteaves (Montreal, Dawson).—Ursachen der Deformationen und der Gebirgsbildung: Dr. E. Reyer (Leipzig, Engelmann).

Serials.—Journal of the Chemical Society, June (Gurney and Jackson).—Meteorological Record, vol. xi., No. 42 (Stanford).—Quarterly Journal of the Royal Meteorological Society, April (Stanford).—Geological Magazine, June (K. Paul).—Natural History Transactions of Northumberland, Durham, and Newcastle-on-Tyne, vol. xi., Part 1 (Williams and Norgate).—The Yale Review, vol. i., No. 1 (Arnold).—Bulletins de la Société d'Anthropologie de Paris, July to December, 1891 (Paris, Masson).—Archives de Sciences Biologiques publiées par l'Institut Impérial de Médecine Expérimentale à St. Pétersbourg, tome i., Nos. 1 et 2 (St. Pétersbourg).—Engineering Magazine, June (New York).—Himmel und Erde, June (Berlin, Paetel).—Journal of the Straits Branch of the Royal Asiatic Society, June Singapore).

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THURSDAY, JUNE 16, 1892.

MECHANICS.

A Treatise on Analytical Statics. With numerous Examples. Vol. I. By Edward John Routh, Sc.D., LL.D., F.R.S., Hon. Fellow of Peterhouse, Cambridge; Fellow of the Senate of the University of London. (London: Macmillan and Co., 1891.)

The Elementary Part of a Treatise on the Dynamics of a System of Rigid Bodies. Being Part I. of a Treatise on the Whole Subject. With numerous Examples. By the Same. (London: Macmillan and Co., 1891.)

WITH these two volumes the mathematical student is completely equipped for the course of Analytical Mechanics, as required for Part I. of the Cambridge Mathematical Tripos.

A second volume is promised of the "Analytical Statics," to cover the parts in Attraction, Astatics, and the Bending of Beams; and this, in conjunction with Part II. of the "Dynamics," will complete his library for the second part of the Mathematical Tripos, according to present regulations.

The great feature of these works is the very complete collections of examples which the author has brought together with great labour, and enriched with many of his own invention, fit to rank among the theorems of the science, rather than as mere problems.

The author is of the opinion that in order to learn Mechanics it is essential to the student to work many examples, taken as far as possible from questions that have actually arisen.

In this opinion he agrees with Fourier, who says:—

> "L'étude approfondie de la nature est la source la plus féconde des découvertes mathématiques. Non seulement cette étude, en offrant aux recherches un but déterminé, a l'avantage d'exclure les questions vagues et les calculs sans issue; elle est encore un moyen assuré de former l'Analyse elle-même," &c.

This is an opinion, however, that has always divided mathematicians into rival camps, and we find Jacobi remonstrating with these words of Fourier by retaliating:—

> "Il est vrai que M. Fourier avait l'opinion que le but principal des mathématiques était l'utilité publique et l'explication des phénomènes naturels; mais un philosophe comme lui aurait dû savoir que le but unique de la science c'est l'honneur de l'esprit humain; et que sous ce titre, une question de nombres vaut autant qu'une question du système du monde."

The developments of mathematics are now so great that specialization is a necessity, so that these rival theories need not come into collision; and the pure mathematician may allow the writer on Mechanics to treat of what the name of the subject implies without being compelled to regard his own Geometry as mere Land-Surveying, according to the strict meaning of the word.

There is a tendency in operation among certain mathematicians, as illustrated by Poincaré's remarks on Maxwell's writings, to degrade mathematical argument to mere Calcul, by reducing the experimental facts on which the theory is based to the barest minimum, and that not always clearly established (we venture to instance the Newtonian Law of Universal Gravitation). A vast array of Analysis is in consequence balanced upon a very small amount of axiomatic experiment, which in many cases the smallest divergence of experimental fact is sufficient to upset.

We had hoped at the outset that Duchayla's proof of the Parallelogram of Forces had disappeared, never to reappear again, but it unfortunately pops up on p. 16.

Considering that Statics deals with the Equilibrium of Bodies would make a great simplification if the word Resultant was abolished, unless when required to mean a single force reversed of a system of equilibrating forces.

In this way a much simpler proof of the Parallelogram of Forces can be constructed, as indicated by Prof. Maxwell in the Mathematical Tripos; and one figure will now serve for all the possible cases arising in the equilibrium of three parallel forces (p. 47).

Again, when the system is in equilibrium, there is no need to introduce the restriction that the bodies are *rigid* (p. 12); the conditions are precisely the same for elastic bodies; but the system having come to rest, the parts are of invariable form. Every structure (the Forth Bridge, for instance) is composed of elastic parts, but the theorems of elementary Statics are still applicable in the investigation of the principal stresses.

Again, by considering balancing couples, the refined theorems concerning the equivalence of couples in the same or parallel planes, and the composition of couples in different planes, are rendered much more convincing.

In accordance with its title of "Analytical Statics," the theorems concerning the composition and equilibrium of forces in space are treated with reference to co-ordinate axes; but Sir Robert Ball's purely geometrical conceptions of the Wrench, Screw, and Cylindroid are introduced, and discussed from a fundamental standpoint.

A chapter on the determination of Centre of Gravity appears in all treatises on Analytical Statics, just as works on Rigid Dynamics begin with a long and tedious chapter on Moments of Inertia: these subjects should form part of the ordinary treatises on Integral Calculus, and so relieve treatises on Mechanics from at least the principal elements of such calculations.

In the application of the Barycentric Calculus to geometry, the author has made a very interesting collection of problems, well calculated to illustrate the power of this method.

The principal theorems of Statics involve profound geometrical argument, and consequently prove difficult to the majority of students, whose proclivities are usually analytical; but in the applications to Catenaries the analytical interest comes again to the front. Considering that the hyperbolic functions can now be obtained tabulated numerically—for instance, in a table by Mr. T. H. Blakesley, published by the Physical Society—it is curious that the author does not employ them in the discussion of the ordinary Catenary, where their use introduces great elegance and simplicity into the analysis. The figure of the Catenary on p. 316 might with advantage be redrawn, so as to exhibit accurately the principal properties of this curve.

Again, in Example 6, p. 352, where the problem of the catenary is discussed under a central attraction or repulsion, varying inversely as the square of the distance, when the hyperbolic functions are used in conjunction with the circular functions, we are able to write the equation of the catenary in the form—

$$l/r = 1 + \sec\alpha\cos(\theta\sin\alpha),\quad\text{or } 1 + \operatorname{sech}\alpha\cosh(\theta\sinh\alpha),$$

including all possible cases; and it is a curious geometrical result that if these curves are rolled on a straight line, the pole will always describe a circle.

The treatment in § 500 of the catenary curve formed by an elastic rope can also be rendered more elegant by the introduction of the hyperbolic functions.

The chapter relating to Catenaries is headed "Strings." But *string* is used only for tying up parcels; we use a *rope* or *chain* in full scale mechanics, and *thread* in a model; the word *thread* should be used when its own weight is to be neglected, and the words *rope* or *chain* when applied to a true catenary.

A short chapter on Graphical Statics is very welcome, and might with advantage be further developed; and the final chapter, on Machines, is of the usual academic character. The interest of this chapter would be much increased if the diagrams, particularly of the Balance and of the Differential Pulley were taken from objects actually in existence.

The author never employs the absolute units of force, the *poundal* or *dyne*, which he has defined in Chapter I., but works throughout with the gravitation unit. This is in accordance with the universal practice; and to satisfy legal and commercial requirements, these absolute units would require to be defined through the intermediate of the gravitation unit, by taking them as one-gth part of the tension of a thread supporting a pound or gramme weight, the value of g being determined from pendulum experiments. There is no apparatus in existence by which the theoretical definition of the poundal and dyne, derived from dynamical phenomena, could be tested with any pretence to accuracy.

The dyne is the unit of force in the C.G.S. system, but it is a great pity that the commercial units, the metre and the kilogramme, were not adopted; the unit of energy would then be the *joule*, and the unit of power the *watt* or *volt-ampere*. Merely, apparently, for the purpose of making

$$W = sV, \text{ instead of } 1000sV,$$

the Committee of the British Association recommended these niggling C.G.S. units; but considering that for ordinary substances, metals, &c., variations of texture render it unnecessary to tabulate densities beyond four significant figures, the factor 1000 is a positive advantage in numerical calculations, as $1000s$ may be replaced by a whole number.

The "Analytical Statics" is a completely new work, but Dr. Routh's "Dynamics of Rigid Bodies" has been the text-book in universal use for thirty years or more, a better testimony to its merits than anything that could be said here.

It is a pity that a sufficient working knowledge of the simple ideas of Moment of Inertia is not given in a course of the Integral Calculus, so that the author might start immediately on some familiar problems of the motion of a body which turns as well as advances, and relegate the bulk of Chapter I. to a later chapter, when the motion of bodies in space is considered. This long chapter at the outset chokes off many students, who would be encouraged if the principles were introduced in smaller doses, and only as required. The gentlemanly knowledge of this subject, as Maxwell called it, which does not go beyond motion in a plane, is a very valuable mathematical training, and few students go beyond this stage.

D'Alembert's Principle is historically important, as a first clear statement of the mode of forming the equations of motion; but now, in accordance with the modern principle of considering the Third Law of Motion, "Action and Reaction are equal and opposite," as defining a stress composed of two equal opposite balancing forces, D'Alembert's Principle should now be merely looked upon as a convenient mode of writing down the equations of Dynamics in an analytical statical form, when stated in the words, "The reversed effective forces and the impressed forces form a system in equilibrium," while "the molecular, cohesive, or internal forces form a system in equilibrium among themselves."

The much-abused word "centrifugal force" still survives, and need not cause confusion if used to denote the normal component of the reversed effective force of a body moving in a curve.

Early methods of argument in Dynamics were very similar to what we now employ in Thermodynamics, in the statement of the Second Law.

Sir George Airy's commentary on D'Alembert's Principle, quoted on p. 52, forms a very curious contrast to the corresponding explanation in Maxwell's "Matter and Motion."

It would be a strange skeleton frame that Sir George Airy would have had to create to propagate the attraction between the Earth and the Moon or Sun; and an interesting subject of speculation arises as to the modification of Newton's Law of Universal Gravitation when the inertia of the skeleton frame became appreciable.

The discussion on the Pendulum is very complete; Kater's pendulum is fully described, but we miss the account of Repsold's pendulum. In this pendulum the effect of the drag of the air is eliminated by making it symmetrical in shape, but unsymmetrical in density. A short account of Repsold's pendulum will be found in the Account of the Great Trigonometrical Survey; but the pendulum is obviously looked upon with suspicion by our officers, as being employed by their Russian rivals on the other side of the Himalayas.

The very perfection of the pendulum as a method of determining g is the cause of its defect as a means of recovering the standard of length, so that equally skilled observers would differ to an appreciable extent if set to work to reconstitute the standard yard from the seconds pendulum; the clause in the Act of Parliament defining the length of the seconds pendulum is in consequence superfluous.

There is something mysterious and unconvincing in § 109, on the "Oscillation of the Watch Balance"; considering that the inertia of the spring itself is neglected, it seems that the final equation of oscillation might well be written down immediately, without the introduction of any approximation.

The Ballistic Pendulum and its theory are fully described; but it should be pointed out that the pendulum in which the gun itself is mounted gives very untrustworthy records, as the effect of the blast of the powder and of the air dragged along with it is so very great. The Ballistic Pendulum is still useful for determining the velocity of small-arm bullets, but for artillery purposes the electric chronograph has completely supplanted it.

Chapter IV. discusses Motion in Two Dimensions, and is perhaps the most generally important and interesting chapter in the book. A complete dynamical terminology is still a desideratum, and many new words must be coined; for, as De Morgan remarks, "We cannot wait for words, because Cicero did not know the Differential Calculus (or Dynamics)." At the same time it is a pity that the old word *Vis Viva*, meaning Mv^2, was not allowed to drop, to be replaced by *Kinetic Energy*, for $\frac{1}{2}Mv^2$. *Vis mortua* is forgotten as the name for *Work*, and *vis viva*, as the other manifestation of energy, should go too.

The dot notation of Fluxions has been introduced in places: this, though easy to write, is difficult to print, and is inconvenient sometimes with tall letters, while others, like i and j, are already in their "dotage."

Dr. Routh would, in our opinion, make the working of the illustrative examples more clear, if he always followed the fundamental principle of taking moments about the centre of gravity, as if it was a fixed point: very few students can be trusted to apply the principle to moments about any other moving point, and the equations of relative motion on p. 178 are better kept out of sight of all but a select few.

Dr. Besant's treatment of questions on Initial Motion is in our opinion simpler of application and quite as rigorous as that given in § 199.

A very good collection of illustrative examples completes this chapter, but we miss the extension of the problem of the motion of a cylinder rolling down an incline to the case of a wheeled carriage or of a railway train, when the rotary inertia of the wheels is taken into account, including the determination of the proper position of the coupling chains and buffers; also the investigation of the stresses in the interior of a swinging body like a ship, not only in causing cargo to shift, but also in its physiological bearing on sea-sickness. An ordinary swing is useless as an antidote to sea-sickness, as the seat is close to the centre of oscillation. To feel the disturbing effect we must mount up above the axis of revolution; and to the deck and up the mast of a ship.

As interesting applications, we may mention the dynamics of billiards, §§ 179–98, and of the quintain in § 178.

After Chapter IV. the author launches off into dynamics in space, and now the difficulty of the subject is more than doubled.

Chapter VII., on Energy (or Vis Viva, as Dr. Routh still prefers to call it), precedes in importance and idea the Chapter VI., on Momentum, and might well change place. The idea of energy as $\frac{1}{2}Wv^2/g$ very soon received a name for its unit in the *foot-pound*, but the corresponding name for the momentum, Wv/g, of *second-pound* is as yet hardly known.

In this chapter the Principles of Dynamical Similitude are discussed. In Geometry the Principle of Similitude asserts that a theorem is true whatever the scale on which it is drawn; but in Dynamics the principle is much more complicated, and great care is required in arguing from the performance of a model or of a machine to one to be constructed to a larger scale. The subject is one of great importance at the present time in the discussion of the design of steamers intended to reduce the time of passage across the Atlantic to something under six days; and the statement of the laws to be applied as affecting steamers, first clearly laid down by Mr. Froude, might well find explanation and illustration at this point.

The impact of two rough elastic ellipsoids is treated in §§ 315, &c., by a mathematical *tour de force;* but the expression *perfectly rough* is never met with outside a Cambridge mathematical treatise. What would be the state of things, for instance, between two bodies in contact, one *perfectly rough* and the other *perfectly smooth?* When we wish to produce this so-called perfect roughness between two bodies, we cut teeth on them, to engage together; and in railway travelling the perfect smoothness of the road due to the employment of wheels must be capable of being turned into roughness by the application of the breaks: the continuous breaks now fitted to express trains have enabled a higher average speed to be maintained.

The General Equations of Motion of Lagrange and Hamilton, discussed in Chapter VIII., are not to be employed by any but very advanced students: the formation of these equations and the conversion of one form into the other constituting difficult and refined applications of the Change of the Variables.

In the case where some of the co-ordinates are absent, this part of the subject has received valuable development from Dr. Routh, by means of a principle now called the Ignoration of Co-ordinates.

The volume concludes with an investigation of the Small Oscillations of a System, important as a Stability Test; in such problems the author expresses the result very concisely by means of the length of the simple equivalent pendulum which synchronizes with the oscillations. An interesting problem to discuss is the theory of Mr. Yarrow's Vibrometer, employed for measuring the vertical vibrations of his torpedo-boats: a platform suspended by springs is found to preserve a constant level, if the free period of the vertical oscillations of the platform is incommensurable with the period of the vibrations of the boat.

It is difficult to know where to stop in writing of treatises such as these two of Dr. Routh, so full of detail and interest; and the two treatises together would provide nearly a year's work for an industrious student, who would thereby derive a thoroughly sound and complete knowledge of the subjects.

A. G. Greenhill.

COLLECTIONS FROM THE ANDES.

Supplementary Appendix to Travels amongst the Great Andes of the Equator. By Edward Whymper. (London: John Murray, 1891.)

THOUGH many travellers in new or little-known regions, who are not naturalists, have been in the habit of collecting to some extent the more remarkable specimens which they have noticed, in various branches of the animal kingdom, yet, as a rule, both such collections and the reports upon them are more or less unsatisfactory to professed naturalists; partly because they usually represent mere fragments of the fauna of the regions explored, and partly because inexperienced collectors often pass over the most interesting species, and bring back common and wide-ranging forms of comparatively little interest.

Alpine climbers in particular, as a class, have done so little for zoology in Europe or the Caucasus, that we hardly expected that Mr. Whymper, whose reputation for daring, determination, and endurance, puts him among the most distinguished of Alpine climbers, would now turn his attention to zoology. He has, however, shown the best possible example to his *confrères* by his Great Andean expedition; and has proved that it is possible without in any way neglecting the special objects of his journey, to do most valuable zoological work; and as the higher regions of the Andes have been neglected by professional collectors, who depend more or less on their success for payment of expenses, the proportion of new Coleoptera brought home by him is very great. Owing, no doubt, to the late Mr. Bates's good advice, Mr. Whymper has secured the assistance of many specialists of eminence in describing his collections, and the work is profusely illustrated with wood-cuts of the highest class, better by far than many of the coloured illustrations which often appear in scientific periodicals.

The total number of species collected amounts, according to Mr. Bates, to about one thousand, but the Diptera, Lepidoptera-Heterocera, Hymenoptera (except the ants), and Arachnida have not been described, on account of the difficulty of finding anyone to work them up; and as the birds do not seem to have attracted much of Mr. Whymper's attention, and fishes are almost wanting in the higher mountain streams, the greater part of the book is taken up by descriptions of the Coleoptera by Messrs. Bates, Sharp, Gorham, Olliff, and others. Messrs. Godman and Salvin have written a chapter on the butterflies, but of these very few occur at elevations of 10,000 feet and upwards; and only two Satyridæ, two species of Lycæna, two Pieris, and two Colias, were taken at or above 12,000 feet. This is a strong proof of the poverty of the high Andes in endemic forms, as compared with the high Alps of Europe and Asia, where, notwithstanding the severity of the climate, a large number of species are found at elevations which, when allowance has been made for the latitude, are much higher than these. This may be accounted for to some extent by the weather, which appears to be, in the high Andes of Ecuador, very wet and windy during the whole year. It is farther explained by the late Mr. Bates in the following remarks, taken from the introduction which he has contributed to the volume:—

"It seems to me a fair deduction from the facts here set forth that no distinct traces of a migration during the lifetime of existing species, from north to south or *vice versâ*, along the Andes have as yet been discovered, or are now likely to be discovered. It does not follow, however, that the Darwinian explanation of the peculiar distribution of species and genera on mountains in the tropical and temperate zones, and in high latitudes of the Old World, is an erroneous one. The different state of things in the New World is probably due to the existence of some obstacle to free migration, as far as regards insects, between north and south, both during and since the Glacial epoch. The problem, like most others relating to geographical distribution, is a complicated one; but there are one or two considerations, likely to be overlooked, which may tend to its solution. One is the great altitude at which the vigorous denizens of the teeming tropical lowlands flourish on the slopes of the Andes. Mr. Whymper found, for example, species of many of the genera of Longicorn Coleoptera characteristic of the lowland forests at altitudes of 9000 and 10,000 feet, and Kirsch has recorded numerous species of *Lampyridæ*, *Lycidæ*, and other families belonging equally to tropical American forest genera, as met with by Reiss and Stübel in Colombia and Ecuador at 12,000 feet. In Ecuador all the warm moisture brought by the eastern trade-winds is not intercepted even now by the wall of the Andes, and wherever that falls, in the depressions, conditions of climate and vegetation will be created suitable to these encroaching tropical forms. If we add to this the barrenness and generally unfavourable conditions of the zone above those altitudes, there can be little wonder that temperate forms have not freely passed along the Andes. Another consideration is that there may have been a breach of continuity of the land in Glacial times, at the Isthmus of Panama, sufficient to prevent free migration. It may, further, be legitimate to speculate on the possibility of the Andes being lower in the tropical zone during the Glacial epoch. A few hundred feet lower than the present altitude, combined with the copious warm rains which must have accompanied the age of ice, would present conditions undoubtedly favourable to the spread of tropical forms over the whole area which would successfully resist the invasion of high northern or southern species. The main principle in distribution, however, is that forms sooner or later, and in proportion to their intrinsic and extrinsic facilities of dissemination, will find their way all over the world to wherever the conditions inorganic and organic are favourable to their acquiring a footing. That these facilities are possessed in a higher degree by plants than insects and some other groups of animals may be a sufficient explanation of the fact that so many species of plants have surmounted the obstacles to their passage from north to south during the last Glacial epoch, while few or no insects have done so. The more distant, or generic, relationship between the insects of Chili and those of the north temperate zone can only be explained on the assumption of a migration at some epoch far more remote than the last Glacial epoch."

Mr. Whymper's book as a whole is a remarkable example of his talent as an explorer, a mountain climber, and an accurate observer both of physical, geographical, and natural history phenomena, and though we have waited eleven years for its appearance, nothing has been lost and much has been gained by this delay, and his book will take rank among the very best works of scientific travel which have ever been written.

H. J. ELWES.

THE HISTORY OF EPIDEMICS.

A History of Epidemics in Great Britain from A.D. 664 *to the Extinction of Plague.* By Charles Creighton, M.A., M.D. (Cambridge: University Press, 1891.)

THE task undertaken by Dr. Charles Creighton in writing a history of epidemics in Britain from 664 (the year of the first pestilence recorded by an authority that can be regarded as contemporary) to the extinction of plague is one of enormous difficulty. The materials for such a history must be sought for high and low; chance allusions in private letters or municipal records will supply links in the chain of evidence for which the writings of the medical authorities of the time may be searched in vain, if indeed there be any medical authorities; and Dr. Creighton found that for his purposes "medical books proper are hardly available . . . until the end of the Elizabethan period, . . . and do not begin to be really important . . . until shortly before the date at which" his present labours end. When such evidence as can be found has been found and sifted, there still remains the most intricate problem of all—that of tracing the epidemics recorded to their origin, accounting for their spread, and in some cases explaining why a country should in modern times be spared diseases which scourged it in the Middle Ages.

No better illustration of these difficulties could be found than is supplied by chapter ii., "Leprosy in Mediæval Britain." The first point that Dr. Creighton has to make clear is that all the so-called lepers were not really lepers. In extreme cases the word "leprosus" may have been used simply as meaning "beggar or common tramp"; elsewhere it may have been applied to victims of syphilis, lupus, and so forth. For the sufferers special provision was no doubt made, on a scale due in part to a morbid or mistaken religious sentiment; but examination of the charters and other documents relating to these charities suggests that, of the supposed foundations for lepers, some were merely refuges for sick and infirm poor, in others provision was made for three or four times as many non-leprous as leprous inmates, while from others, towards the end of the thirteenth century, the lepers were disappearing or getting displaced. Finally, the author concludes that the prevalence of true leprosy at any time in England was probably not so great as in the worst provinces of India at the present day; but, however justifiable scepticism as to its supposed ravages may be, that the disease really did prevail can hardly be doubted, and the reasons for doubt are lessened, if a *vera causa* for its presence can be found. Such a *vera causa*, compatible with its subsequent disappearance, may be discovered, not in "importation," *e.g.* by Crusaders—a suggestion Dr. Creighton does not consider worth thinking about—but in the staple diet of the times, a semi-putrid or toxic character of animal food combining with other depressing influences to give rise to leprosy, just as a similar character of bread or porridge gives rise to pellagra.

We have given the arguments of this chapter somewhat in detail, because the criticism which obviously applies to them, applies elsewhere. Considering the uncertainty which surrounds the facts, it is clear that the traditions of the leprosy of the past cannot very materially assist, though they may be explained by, the study of modern leprosy. Similarly, in the case of the plague, to which naturally Dr. Creighton devotes much of his book, to say nothing of that old question, the value of the evidence of the Bills of Mortality, the inquirer is met at once by the great difficulty of knowing when "the plague" which is spoken of as invading out-of-the-way places really was the genuine plague—a point of vital importance, as soon as any etiological questions are raised, and we may here observe that Dr. Creighton writes :—

> "In concluding the career of the sweat in England, we may pass from it with the remark that it did not cease until other forms of pestilential fever were ready to take its place. The same explanation remains to be given of the total disappearance of the plague from England after 1666: it was superseded by pestilential contagious fever, a disease which was its congener, and had been establishing itself more and more steadily from year to year as the conditions of living in the towns were passing more and more from the mediæval type to the modern."

It would be impossible here to enter into the merits or the reverse of all Dr. Creighton's explanations of the facts he records. In the chapter on small-pox, which is likely to be the one first consulted, we find a passage which disarms criticism: "It has been the fate of small-pox as an epidemiological subject to be invested with bigotry and intolerance." Yellow fever has as yet hardly sunk to that deplorable level; and as Dr. Creighton's theory appears to be that "the dysenteric matters of the negroes" carried on the slave ships "had themselves in turn bred an infection of yellow fever for the whites," it may be asked whether the alleged protection of Africans of pure blood from the infection of yellow fever "in all circumstances ashore or afloat, . . . not by acclimatization but by some strange privilege of their race," is either supported by all recent authorities, or not capable of the explanation that in infancy they may pass through some disease too slight to be recognized as yellow fever, but which serves to confer immunity.

The general impression left upon the mind by this history is that it would have been a wise policy to make two books instead of one out of the materials collected —in one simply to bring together such facts as Dr. Creighton's industry has gleaned from the authorities, and in the other to enter upon the questions of etiology, which are bound to give rise to interminable discussion.

Besides those we have mentioned, gaol fevers, influenzas, "the French pox," and scurvy in early voyages, are the principal diseases treated of in this volume. In dealing with influenza Dr. Creighton draws attention to the relation in point of time between the outbreaks in the latter half of the sixteenth century and great epidemics of plague, and a somewhat similar relation between fever and influenza and exceptional climatic conditions in the years 1657-59.

OUR BOOK SHELF.

Mineralogy. By Frederick H. Hatch, Ph.D., F.G.S., of the Geological Survey of England and Wales. (London: Whittaker and Co., 1892.)

DR. HATCH has followed up the publication of his excellent "Introduction to the Study of Petrology," recently noticed in these pages, by a little book on mineralogy, which will, we think, be of equal service to students. He has recognized the fact that for one person who desires to enter upon a systematic study of mineralogy, regarded as a natural-history science, there are twenty who need only such an amount of mineralogical information as will enable them to profitably commence the study of geology. We think, therefore, that the prominent place given to the felspars, the pyroxenes, the amphiboles, the micas, and similar common rock-forming species in this work, is fully justified; and not less so the unsystematic but convenient grouping of other minerals as "ores and veinstones," "salts and other useful minerals," and "gems or precious stones." De Lapparent has indeed shown how a classification of minerals according to their mode of occurrence may be employed even in a systematic treatise; but Dr. Hatch's more humble attempt is not open to the criticism to which an ambitious work on the same lines would obviously be liable. It is clear that in a book of this kind there is not much scope for originality of treatment, but Dr. Hatch has admirably united brevity and clearness in his treatment of the crystallographical and physical characters of minerals. His method of giving the names and commonly employed reference letters to the crystal-combinations which he figures is well adapted to prepare the student for consulting larger treatises on the subject. So, too, the reference to the use of symbols, though it must evidently be very slight in a work of the dimensions of that before us, is eminently judicious. A short table of symbols of the chief forms belonging to each system, according to Miller and Naumann, will enable the beginner to recognize the meaning of all the very commonly occurring combinations; and it is clearly inexpedient to attempt more than this in such a very elementary work. We can confidently recommend the book as an excellent summary of mineralogical science, adapted to the wants of the geological student; and we believe the perusal of this small work may even be of advantage to those who desire to enter upon the more systematic study of the science of mineralogy. J. W. J.

To the Snows of Tibet through China. By A. E. Pratt, F.R.G.S. (London: Longmans, Green, and Co., 1892.)

The author of this book says in the preface that he has done his best "to withstand the temptation to generalize from limited experience, to which travellers in China seem peculiarly liable." Yet in his last sentence he expresses the opinion that several incidents he has mentioned "will show what a credulous and cowardly race the Chinese are." It ought surely to have occurred to him, when he set down this harsh and rather foolish judgment, that it was a striking example of the kind of generalization which he had wished to avoid. Fortunately the statement, although it seems to convey Mr. Pratt's final impression of the Chinese people, does not represent the general character of his work, in which scientific readers will find a good deal to interest them. He went to China in 1887 for the purpose of studying the natural history of the country, and remained until 1890, fixing his head-quarters at Ichang, a town on the left bank of the Yang-tze-Kiang, 1110 miles from its mouth. He crossed the frontier of Tibet, and at Ta-tsien-lu met Mr. Rockhill, whose excellent account of travels in Tibet we lately reviewed. Mr. Pratt worked hard in the various regions he visited, and collected many valuable specimens in several departments of natural history. He has not a very bright or attractive style, but many of his facts are themselves so interesting, and his enthusiasm as a collector is so keen and persistent, that there are few passages which his readers will desire to skip. In an appendix, Dr. Albert Günther gives a list of the species of reptiles and fishes brought by Mr. Pratt from the Upper Yang-tze-Kiang and the province Sze-chuen, with a description of the new species. There are also lists of birds and of Lepidoptera.

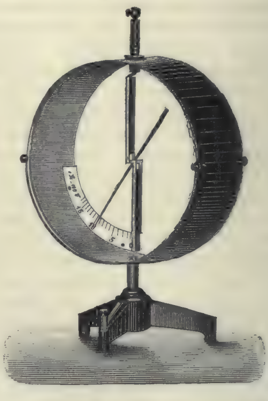
LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Absolute Electrometer for Lecture Purposes.

I thought it might be welcome to some of your readers to be made acquainted with the following simple and cheap instruments which I have now used for some years with advantage in lectures, and also for many scientific purposes. They are electrometers, which are divided directly into volts. The needle, which is made of aluminium, moves about a horizontal axis of hard steel, and is repelled from the vertical brass piece connected with the knob above. The instruments have the advantage that they are much easier of manipulation than the gold-leaf electroscope, while the sensibility is nearly the same, and fully suffices for all lecture purposes. Potentials are read off directly in volts, so that the measurements in the experiments on electrostatics and electrodynamics can all be referred to the same unit, whereby the conception of the student gains in distinctness, and the lecture in simplicity. In consequence of the specially careful workmanship, the needle adjusts itself quickly and with certainty, so that readings may be made to about 10 volts. The back and front consist of glass disks 1 mm. thick, each of which covers a plate of zinc of the same size, out of which are cut two equal and opposite slits, through which the position of the needle on the brass scale is read off. The readings of the instrument are only correct when these plates are in position.

When the instrument is used in the lecture, the two plates are taken away, and the back glass plate covered with tissue paper, the instrument being illuminated from behind. The deflections are then easily visible in a room for more than a hundred students.



The method of graduation of these instruments I have described in full in *Wiedemann's Annalen*, vol. xliv., 1891, p. 771. They can be procured from the University mechanician here, Herr Albrecht, in three different sizes, 0–1500, 0–4000, and 0–10,000 volts. The first of these is the substitute for a gold-leaf electroscope. Herr Albrecht also makes the instruments for technical purposes. F. Braun.

Physical Laboratory, Tübingen, May 28.

Saturn's Rings.

The writer of the "Astronomical Column," in your number of June 2, directs attention to some observations of M. Bigourdan on certain peculiarities in the appearance of the following arm of Saturn's Rings observed by him on May 21. He mentions in particular a protuberance situated near Cassini's division. This, I think, is easily accounted for in a quite different manner. At 9h. 6m. p.m., according to Marth's ephemeris, two satellites, Enceladus and Tethys, were in conjunction with the east end of the ring. They were going in apparently opposite directions, Tethys away from Saturn. Their conjunctions with the middle of the Cassini division would, I find, take place at 8h. 36m. p.m. for Tethys, and at 9h. 36m. p.m. for Enceladus. Both satellites would be so close to the ring as to appear inseparable from it. Tethys, moving in an orbit inclined as much as 65′ to the plane of the rings, might easily be half superposed in appearance upon the *northern* boundary of the rings. The following remarks are from my observation-book of date May 21:—

"9h. 13·5m. G.M.T. The broadening of the east ansa near its end is probably due to Tethys and Enceladus being on opposite sides of it near its east end. 9h. 22m. The east ansa seemed a little longer than the west, perhaps due to Tethys now following it. Dione was seen close to the east end."

With the other observations and remarks of M. Bigourdan I quite agree. The straightening of the northern edge of both ansæ has frequently been noticed by me both before and after May 20. So lately as June 3 both ansæ seemed broadest at a distance of three-fifths of their length from the ball, and the following ansa was almost detached from the ball, partly by the shadow thrown by the ball on it, and partly by the more elevated part of the middle ring concealing all within it in the neighbourhood of the ball. A. FREEMAN.

Murston Rectory, Sittingbourne, June 6.

Aurora.

THE aurora of May 18 was seen here. I first noticed it at 11 p.m. (Dublin time), and watched it until 1 a.m., though I did not see either the beginning or the ending. It extended from west-north-west to north-north-east, and had a general altitude of 30°, though occasional streamers reached beyond Polaris. It was moderately bright, but certainly not brilliant, and showed no colour. About 12 o'clock horizontal streamers began to show themselves like electric search-lights, and continued for some time, their appearance being accompanied by a lengthening upwards of the radial streamers. The air was slightly hazy, and there was much stratus about, with detached masses of cumulo-stratus coming up from the west. Wind-force 3 of Beaufort's scale; barometer 30·05, stationary.

JAMES PORTER.

Crawford Observatory, Queen's College, Cork, May 31.

The Atomic Weight of Oxygen.

I NOTICE that Lord Rayleigh gives the following summary of results on the atomic weight of oxygen:—

Dumas	1842	15·96
Regnault	1845	15·96
Rayleigh	1889	15·89
,,	1892	15·882

showing the remarkable fact that the atomic weight has been steadily decreasing for the last fifty years. I would suggest, as the explanation of this, that the increased population of the world, together with the great consumption of coal, have caused great wear and tear of these atoms, so that they are now mostly deficient in weight. It would seem, in fact, desirable that a Congress of chemists should be called to consider the question of providing for the renovation of the oxygen supply, and issuing trustworthy atoms of the standard weight, 16, as sealed patterns.

ROBT. LEHFELDT.

Firth College, Sheffield, June 3.

The Nitric Organisms.

I AM most reluctant to occupy any of your space with a claim to priority. A statement made on p. 137 of your last issue can hardly, however, be allowed to pass without notice. Dr. P. F. Frankland states in his lecture at the Royal Institution that the possibility of the existence of a nitric organism was foreshadowed by himself, and that this hypothesis has recently been confirmed by Winogradsky. He then describes the method adopted by Winogradsky for separating the nitric from the nitrous organism, and the chemical properties of the former. The fact that the existence of a nitric organism was proved in the first instance by myself, its separation from the nitrous organism effected, and its chemical behaviour studied, before any publication on the subject by Winogradsky, is *entirely omitted!* Frankland's statement of the case is the more remarkable as Winogradsky frankly admits in his paper that our results were nearly the same, and that his were published subsequently to my own.

R. WARINGTON.

Harpenden, June 10.

Carnivorous Caterpillars.

EVERY experienced breeder of Lepidoptera knows to his, or her, cost that many caterpillars are either habitually, or casually, carnivorous and cannibalistic.

Useful hints on this subject are given in Dr. Knaggs' "Lepidopterist's Guide" (Gurney and Jackson).

Lewisham, June 13. R. McLACHLAN.

The Cuckoo in the East.

IN May 1887 I wrote to you that I had heard the cuckoo at Mussoorie. This year, on coming up here, I heard it at Doneira (about 2000 feet) and at Mamul (4000 feet). I have been here five days and have not heard it at all. There has been a deficiency of rain here, and it has been unusually hot. Both notes were very clear and distinct.

Dalhousie, May 22. F. C. CONSTABLE.

THE NEW LONDON UNIVERSITY.

WE have received for publication from the Association for Promoting a Professorial University for London the following proposals, adopted by the Association at a meeting held on Tuesday last:—

(1) It is desirable that there should, if possible, be one University in London.

(2) The objects of the University should be to organize and improve higher education and also to promote the advancement of science and learning.

It is desirable that the University be constituted on the following lines:—

(3) Subject to Clauses (9) and (12) the University to be governed by a Senate which shall ultimately consist of the Professors and a certain number of Crown nominees.

(4) The Professors to be nominated in the first instance by some independent authority, such as the Crown or the Commission contemplated in Clause (14), afterwards in such manner as the Senate may determine.

(5) The University to have power to absorb institutions of academic rank in London, which may be willing to be absorbed, due provision being made for protecting the interests of the teachers in such institutions, and for preserving the character of special trust-funds.

(6) The University to have the power of appointing Readers and Lecturers, either to supplement the teaching of the Professors, or to deliver graduation or other courses of lectures within the metropolitan area at such places as may be determined by the Senate.[1]

(7) The University to have power to grant degrees and to institute degree examinations. These examinations may, if found necessary, be different for those who have followed prescribed courses and for those who have not. Each Professor of the University to be *ex officio* an Examiner in the subject of his chair, but not necessarily to take part in every examination in that subject. Examiners, who shall not be Professors in the University, to be appointed by the Senate to take part in all degree examinations.

(8) The Professors, Readers, Lecturers, and other Teachers of the University to be grouped into Faculties, which shall have such consultative and administrative powers as shall be determined by the Senate.

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[1] This side of the University work would probably include teaching of the following kinds:—

(*a*) Teaching, conducted in the University Buildings, supplementary to that of the Professors.

(*b*) Courses of instruction of a special or advanced character recognized by the University, *e.g.* of the type given by the German *Privat-Docenten*.

(*c*) Teaching of a more or less academic character conducted by lecturers appointed by the University at Institutions and Colleges, the objects or the standing of which render complete absorption into the University undesirable.

(*d*) Lectures at various local centres of the type known as "University Extension" lectures.

(*e*) Courses of lectures or occasional lectures by members of the University staff, or by other persons recognized by the University, for which a convenient centre might, with the co-operation of the Corporation of London and of the Mercers' Company, be found at Gresham College.

(9) The Body of Graduates in Convocation assembled to have the power of appealing to the Privy Council, but to have no veto upon the action of the Senate. The Chairman of Convocation to be *ex officio* a member of the Senate.

The Medical Schools will probably require special treatment. Though they might advantageously hand over the teaching of pure science to the University, each school might retain control over its own teaching of medicine and surgery and over the funds devoted thereto.

(10) The Medical Faculty to consist of representatives elected by the Teachers in recognized London Medical Schools.

(11) The recognized Medical Schools to be determined in the first instance by the Commission referred to in Clause (14), but afterwards from time to time by the Senate, subject to appeal to the Privy Council.

(12) A certain number of the members of the Medical Faculty to be nominated University Professors in accordance with the provisions of Clause (4). The number of Medical Professors on the Senate not to exceed one-fourth of the total number of University Professors on the Senate.

(13) A teacher of pure science in a recognized Medical School to become a Member of the Faculty of Science, whenever the appointment to his post is entrusted permanently or *pro hac vice* to the Senate of the University.

(14) To facilitate in the first instance the organization of the University, it is suggested that a small and independent Commission of legal and educational authorities be appointed by Act of Parliament with full powers—

(*a*) To investigate and determine upon the claims of institutions wishing to be absorbed under Clause 5.

(*b*) To arrange for the proper disposal of the trust-funds of those institutions which may be absorbed, and to determine the conditions under which their property shall be vested in the Governing Body of the University.

(*c*) To arbitrate on all matters concerning the interests of existing teachers as affected by the action of Clause (5), and

(*d*) Generally to make such arrangements as may be necessary for the establishment of the University on the foregoing lines.

We are requested to add that the names of those desirous of supporting the Association will be received by any member of the Executive Committee,[1] or may be sent directly to the Secretary (Prof. Karl Pearson, Christchurch Cottage, Hampstead, N.W.). The Association already numbers some seventy members, including Profs. H. E. Armstrong, F.R.S., W. E. Ayrton, F.R.S., F. O. Bower, F.R.S., O. Henrici, F.R.S., E. Frankland, F.R.S., E. Ray Lankester, F.R.S., F. Max Müller, O. J. Lodge, F.R.S., Norman Lockyer, F.R.S., W. J. Russell, F.R.S., W. A. Tilden, F.R.S., H. Marshall Ward, F.R.S., Principals H. R. Reichel, W. M. Hicks, F.R.S., and C. Lloyd Morgan, besides many other names equally well known in literature, science, and art. A complete list will shortly be issued.

SUBDIVISIONS IN ARCHÆAN HISTORY.[2]

I. *Subdivisions based on Kinds of Rocks.*

WERNER'S idea that kinds of rocks and grade of crystallization afford a basis for the chronological subdivision of crystalline rocks is more or less apparent in nearly all attempts that have since been made to lay down the general subdivisions of Archæan terranes. The "fundamental gneiss" has gone to the bottom and the thinner schists to the top. There is a degree of truth in the idea. But the assumptions are so great that at the present time little reason exists for the earnestness sometimes shown by advocates of such systems. The idea has little to sustain it in the known facts of geology. The following are sufficient to decide the question.

According to the thorough petrological and geological study of the rocks of the Bernardston region by Prof. B. K. Emerson [1]—a region in the Connecticut valley, in the towns chiefly of Bernardston, Massachusetts, and Vernon, Vermont—there are the following rocks: granite, largely feldspathic; dioryte, so like intrusive dioryte that it had been pronounced trap; quartz-dioryte; granitoid gneiss faintly foliated with biotite and passing into the granite; hornblende schist; quartzyte; quartzyte prophyritic with feldspar crystals; staurolitic and garnetiferous mica schist; hydromica schist; argillyte; massive magnetite, making a bed of magnetite rock; along with coarsely crystalline limestone and quartzytic limestone containing Crinoids, Corals, and Brachiopods: all together making one series of rocks of later Devonian age. My own observations in the region confirm the conclusions of Prof. Emerson. Such facts prove, moreover, that "massive" as applied to crystalline rocks does not signify *igneous*. The granite is not eruptive granite, but part of a stratum which is elsewhere quartzyte, the quartzyte graduating into granite; the latter was never in fusion.

Again: on the borders of New England and New York there are schists of all gradations from massive Cambrian gneiss to Cambrian and Hudson River hydromica schist and argillyte, the age fixed by fossils. Becker reports similar facts from the Cretaceous of California. Such observations, and others on record, make it hazardous to pronounce any gneiss in an Archæan area "fundamental gneiss," or any associated slaty schist the younger of the two. It may be true; but it may not be. It is probable that the thin-bedded schists are absent from the older Archæan, but not that the thick-bedded and massive are absent from the later Archæan.

The little chronological value of kinds of crystalline rocks in the later Archæan comes out to view still more strongly if we consider with some detail the length and conditions of Archæan time.

The earth must have counted many millions of years from the first existence of a solid exterior, when the temperature was above 2500° F., to the time, when, at a temperature below 1000° F.—probably near 500° F., supposing the atmospheric pressure to have then been that of 50 atmospheres—the condensation of the waters of the dense aërial envelope had made such progress that an ocean, moving in tides and currents, had taken its place on the surface.[2] There were other millions afterward along the decline in temperature to the 180° F. mark—180° F. the mean temperature of the ocean—when, according to observations on living species, the existence of plants in the waters became, as regards temperature, a possibility;[3] and still other millions from the 180° F. mark to that of 120° F., or nearly, when marine animal life may possibly have begun its existence. And since cooling went on at a decreasing rate toward the end, time was also long from the 120° F. mark to that of a mean oceanic temperature of 90° F., or below it, when Paleozoic life found congenial conditions in the water. The mean temperature now is about 60° F.

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[1] This Committee at present consists of the following:—F. V. Dickins, G. Carey Foster, R. S. Heath, E. Ray Lankester, Karl Pearson, H. E. Roscoe, A. W. Rücker, T. E. Thorpe, W. C. Unwin, W. F. R. Weldon.

[2] Reprinted from the June number of the *American Journal of Science*, rom advance sheets forwarded by the author. The paper is to be continued in the *American Journal of Science*.

[1] A description of the "Bernardston Series" of Metamorphic Upper Devonian Rocks, by Ben K. Emerson, *American Journal of Science*, III., xl., 263, 1890.

[2] R. Mallet estimated, in view of the density of the atmosphere—over 200 atmospheres to the square inch—that the first drops of water may have been condensed on the earth's surface when the temperature was that of molten iron.—*Phil. Mag.*, January 1880.

[3] They live now in waters having a temperature of 200° F., Brewer, at Pluton Creek, California; 185°, W. H. Weed, Yellowstone Park. Moreover germs of Bacilli have germinated after having been boiled for an hour.

The ocean, sooner or later after its inaugural, began the work of making permanent sediments, that is sediments that were not speedily recrystallized; and these sediments, through the millions of years that followed, must have been of all kinds and of great thickness.

The conditions became still more like the present after the introduction of life with the further decline of temperature. Even before its introduction, iron oxides, iron carbonate, calcium carbonate, calcium-magnesium carbonate, and calcium phosphate had probably commenced to form, for the atmosphere, although it had lost the larger portion of its water-vapour, still contained, as writers on the "primæval earth" have stated, the chief part of its carbonic acid, amounting to all that could be made from the carbon of the limestones, coal and carbonaceous products now in the world. It had also a great excess of oxygen—all that has since been shut up in the rocks by oxidations. And these most effectual of rock-destroying agents worked under a warm and dripping climate.

The amount of carbonic acid, according to published estimates, has been made equivalent in pressure to 200 atmospheres, or 3000 pounds to the square inch. 200 is probably too high, but 50 atmospheres, which is also large, is perhaps no exaggeration. Hence, the destruction of rocks by chemical methods must have been, as Dr. Hunt and other writers have urged, a great feature of the time; and long before the introduction of living species, the temperature had so far declined that the making of silicates must have given way in part to the making of deposits of carbonates and oxides.

But with the existence of life in the warm waters, through the still later millions of years, there should have been, as Weed's study of the Yellowstone Park has rendered probable, abundant calcareous secretions from the earliest plants, and, additions later, through the earliest of animal life. Great limestone formations should have resulted, and large deposits of iron carbonate, and perhaps iron oxides, over the bottom-sediments of shallow inland or sea-border flats, besides carbonaceous shales that would afford graphite by metamorphism.

In fact, long before the Archæan closed, the conditions as to rock-making were much like those that followed in the Paleozoic. Surely, then, all attempts to mark off the passing time by successions in *kinds* of rocks must be futile. Some *varieties* of the various kinds of rocks are probably Archæan only; but not all those of its later millions of years. Even crystalline and uncrystalline may not be a criterion of chronological value. The beds of the Upper Archæan, under the conditions existing, may well, over some regions, be uncrystalline still, and may include carbonaceous shales that hold to this time their carbonaceous products. Such uncrystalline beds may now exist over the Continental Interior; for the great Interior has generally escaped when metamorphic work was in progress on the Continental borders.

The amount of carbonic acid is most readily estimated by first obtaining the probable amount for all post-Archæan sources, and then adding to this that which is indicated by Archæan terranes. The calculation is here given in detail that others may use it for deductions from other estimates.

For the estimation there are the following data. A cubic foot of pure limestone which is half calcite and half dolomite and has the normal specific gravity 2·75, weighs 171·4 pounds; and this, allowing for $\frac{1}{12}$th impurity, becomes 157 pounds and corresponds to 72 pounds of carbonic acid. A cubic foot is equal to an inch-square column 144 feet in height. Since 72 is half of 144, each foot of the column of such limestone contains half a pound of carbonic acid. Hence a layer of the limestone one foot thick would give to the atmosphere, on decomposition, half a pound of carbonic acid for each square inch of surface.

A foot layer of good bituminous coal containing 80 per cent. of carbon, $G=1·5$, will give to the atmosphere by oxidation 1·9 pounds of carbonic acid per square inch of surface.

If the mean thickness of the limestone over the whole earth's surface, that of the oceans included, reckoned on a basis of $\frac{1}{12}$th impurity, is 1000 feet, the contained carbonic acid amounts according to the above to 500 pounds per square inch, or 34 atmospheres (of $14\frac{3}{4}$ pounds), and if the mean thickness of the coal is one foot, the carbonic acid it could contribute would be 1·9 pounds per square inch. Adding these amounts to the carbonic acid corresponding to the carbon in the mineral oil and gas and other carbonaceous products of the rocks and organic life, supposing it to be six times that of the coal, the total is 513·5 pounds, or 35 atmospheres. The mean thickness of Archæan calcium, magnesium, and iron carbonates is not a fourth of that of post-Archæan. Estimating the carbonic acid they contain and that corresponding to the graphite of the rocks at ten atmospheres, the whole amount becomes 45 atmospheres.

To bring the amount up to the estimate for early Archæan time of 200 atmospheres of carbonic acid, the mean thickness of the limestone for Archæan and post-Archæan time should be taken at nearly 6000 feet.

Part of the limestone of post-Archæan terranes was derived from the wear and solution of Archæan limestones, iron carbonate, &c., and hence all the 35 atmospheres to the square inch were not in the atmosphere at the commencement of the Paleozoic. But if we reduce the 35 atmospheres, on this account, to 25 atmospheres, it is still an enormous amount beyond what ordinary life, even aquatic life, will endure. Reducing the estimated mean thickness for the limestone layer over the globe from 1000 to 500 feet would make the amount nearly one half less.[1]

The making of carbonates early began the work of storing carbonic acid and purifying the atmosphere; and the introduction of life increased the amount thus stored, and added to it through the carbonaceous materials from living tissues contributed to the earthy deposits. But with all the reductions that can be explained, the excess is still very large. It has been proved by experiment that an excess also of oxygen diminishes the deleterious influence of carbonic acid on plants; and that if the amount of this gas is made equal to that of the oxygen in the present atmosphere, plants will still thrive. How far this principle worked in early time cannot be known.

2. *Subdivisions based on Stratification.*

The stratification in an Archæan region affords the only safe and right basis for subdivisions. This method has been used in the separation of the Huronian from the older Archæan; and recently, with good success, by Irving and Van Hise in the study of the Penokee-Marquette region, or the Huronian belt of Wisconsin and Michigan. The intimate relation of the beds in the series has been worked out and their unconformability with the lower rocks thus ascertained, besides the stratification and constitution of the iron-ore series within the belt. This is the first step toward that complete study which should be carried on throughout all Archæan areas, however "complex." The distribution of the rocks and their apparent or real stratigraphic succession, whether massive or schistose, the positions of the planes of foliation or bedding, the unconformities in superposition, and those of mere faulting, and all structural conditions, should be thoroughly investigated. Correlation by likeness of rocks has its value within limited areas, but only after much questioning.[1] The work is easy in its methods, yet perplexing because in North America the uplifts and flexures of different periods have in general taken place in parallel directions, so that unconformabilities are disguised, especially when the two formations are nearly alike in grade of metamorphism. Follow along the overlying to places where its metamorphism is of low grade, and there may be success.

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[1] A right estimate is very desirable. If made for North America, it could not be far out of the way to assume it to be a mean for like areas of the other continents as regards the limestone. But with the best possible result for the continents, the oceanic area, three times that of the continents, and out of the reach of investigation as to depths of bottom deposits, remains a large source of doubt.

There is a first point of special importance to be accomplished by Archæan investigation. The Huronian of the Penokee-Marquette region is partially metamorphic. To the east, the iron ore, according to the describers, is mainly metamorphic magnetite and hematite; to the west, especially in the Penokee region, it is largely iron carbonate, or the ore in its original state. Other facts show a diminishing grade of metamorphism to the westward. In the Penokee district, the ore is underlain by a bed of "cherty limestone," the chert of which, like the interlaminated jasper of the iron ore bed, is regarded by Van Hise as probably of organic origin, like later chert. It has among the overlying beds carbonaceous shales containing, according to Chamberlin, 40 per cent. of carbon, bearing thus evidence of very large organic carbonaceous contributions when in process of formation. The great beds of iron ore, the upward gradation eastward in metamorphism, the relations in position to the admitted Archæan adjoining it on the south, seem to prove the Huronian series to be Upper Archæan, as it has been generally regarded, but in a non-metamorphic and partially metamorphic condition. The question thence arises: Are the ore-bearing rocks of the Archæan of Eastern Canada, New York, New Jersey, and other parts of the Appalachian chain, Huronian in a state of *high-grade* metamorphism? Are the chondroditic limestones, which, in some localities, occur in and with the ore, part of the Huronian formation? Does the eastern iron-bearing series rest unconformably on inferior Archæan?

The *Algonkian* (or Agnotozoic) beds belong either to the Archæan or to the Paleozoic.

The Archæan division of geological time is of the same category with the Paleozoic, Mesozoic, and Cenozoic; all are grand divisions based on the progress of life, and they include together its complete range. There is no room for another grand division between Archæan and Paleozoic any more than for one between Paleozoic and Mesozoic. In contrast, the Algonkian division is not above the Cambrian in grade, it being based on series of rocks. Its true biological relations are in doubt, because fossils representing the supposed life of the period are unknown, or imperfectly so. The discovery in any rock so-called of Trilobites, Crustaceans, Mollusks, Brachiopods, or Crinoids, whatever the species, would entitle such rocks to a place in the Paleozoic, and either within the Cambrian group or below it. Walcott has already reported such fossils from the beds at the bottom of the Colorado cañon referred by him to the Algonkian—namely, besides a Stromatoporid, a small Patella-like or Discina-like shell, a fragment of a Trilobite and a small Hyolithes—forms which make the beds Paleozoic beyond question.

3. *Subdivisions based on Physical and Biological Conditions.*

Although the physical and biological conditions of the early globe are within the range of observation, there are generally admitted facts which afford a basis for a philosophical division of the time; and from it geology may derive instruction. The subdivisions to which we are led are the following:—

I. The ASTRAL æon, as it has been called, or that of liquidity.

II. The AZOIC æon, or that without life.

(1) The *Lithic era*, commencing with completed consolidation: the time when lateral pressure for crust-disturbance and mountain-making was initiated, and when metamorphic work began.

(2) The *Oceanic era*, commencing with the ocean in its place: oceanic waves and currents and embryo rivers beginning their work about emerged and emerging lands, and the tides, the retarding of the earth's rotation.

III. The ARCHÆOZOIC æon, or that of the first life.

(1) The *era of the first Plants*: the Algæ and later the aquatic Fungi (Bacteria); commencing possibly with the mean surface temperature of the ocean about 180° F.

(2) The *era of the first Animal life*: the Protozoans, and forms related to the embryos of higher invertebrate species; commencing possibly with the mean surface temperature of the waters about 120° F., and ending with 90° F. or below.

The subdivisions, as is evident, mark off great steps in the progress of the developing earth, although the rocks bear no marks of them that can be distinguished.

The Huronian period covered, probably, much of Archæozoic time; and this is all in the way of correlation that can be said. It is well to note here that if the Eozoon is really animal in origin, the "Laurentian" rocks of Canada in which it occurs must be Huronian, or the later of Archæan terranes.

Respecting the Oceanic period it is observed above, "*commencing with the ocean in its place.*" It appears to be almost a physical necessity that the oceanic depression should have been made in the first forming of the solid crust, if the globe cooled to the surface from the centre outward; that is, unless a liquid layer remained long afterward beneath the crust.

The depression was certainly made long before the close of Archæan time. For the enormous amount of rock-making of the Archæan over the continent implies the existence of emerged rocks with reach of the decomposing, eroding, and denuding agencies of the atmosphere and atmospheric and oceanic waters. A submergence in the ocean of 50 feet is almost a complete protection against mechanical and chemical wear. Moreover North America has its Archæan lands not only in the great nucleal mass, 2,000,000 square miles in area, but also in the series of Archæan ranges parallel to the outlines of the nucleus, which extend eastward to the eastern limit of Newfoundland, and westward to the Pacific. And it has correspondingly shallow-water Cambrian deposits lying between these ranges from Eastern Newfoundland and the coast-region of New Burnswick and Massachusetts, westward across the continent about most of the Archæan outcrops, to within 300 to 400 miles of the Pacific Ocean, as shown by Walcott.

There is hence reason for the conclusion that, at the close of Archæan time, the continent of North America was present not merely in outline, but also in general features, and at shallow depths where not emerged.

This fact with reference to North America means much. It means that by the end of Archæan time, the continents generally were essentially in a like condition—outlined and at shallow depths where not emerged; that, therefore, the oceanic depression was then large and deep enough to hold the ocean. Further, this last fact indicates, if the mean level of the continents was coincident with the water's surface, that the oceanic depression had already a depth of 12,000 feet, or that of the present mean depth of the waters; and that the lowering, through later time, of the bed 1500 feet on an average (or 2000 feet according to other estimates) would give the continents their present mean height. And it is a fact of deep geogenic significance, that nearly 1000 feet of this mean height was received after the beginning of the Tertiary.

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[1] As a preliminary in the study of any such region, thousands of dips and strikes of planes of foliation or bedding should be taken (in imitation of Percival's work before 1842, mentioned in the note on p. 440 of the last volume of the *American Journal of Science*), and all should be plotted on maps of large scale by means of symbols with affixed numbers recording the dips and strikes, for full comparison in the final elaboration. Even the Penokee-Marquette region needs further investigation with a clinometer-compass in hand

Before commencing the study of any crystalline rocks, models of flexures should have been studied until the fact is fully appreciated that a flexure having an inclined axis—the commonest kind—ranges through 180°, or nearly, in its dips and strikes, and until the characters of the bedding in different transverse sections of flexures are well apprehended. A good model for studying flexures may be made from a cylindrical stick of coarse-grained wood having the bark on (if of a smooth kind); it may be about four inches in diameter and twelve to fifteen long. Draw a straight line through the centre of one end; and from this line saw across obliquely to the edge at the opposite end. After planing smooth the sawed surface, the layers of the wood may then be coloured by groups; and three colours, or two besides that of the wood, are better than more. The model of a flexure having an inclined axis is then complete. Cross-sections of the model may be cut and the colours added to the new surfaces. For models of overthrust flexures, this method is not practicable, as wood of elliptical section would be required. They may be made of paper-pulp of three colours.

JAMES D. DANA.

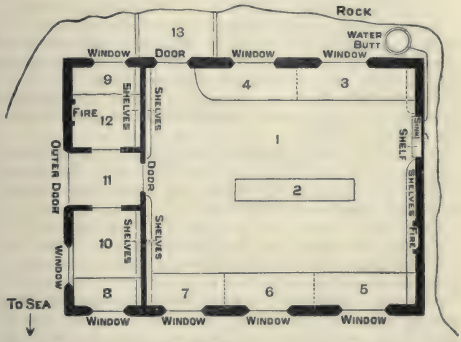
OPENING OF THE LIVERPOOL MARINE BIOLOGICAL STATION AT PORT ERIN.

THE Liverpool Marine Biology Committee, which commenced the investigation of the fauna and flora of Liverpool Bay and the neighbouring seas seven years ago, and has kept up a small biological station on Puffin Island, Anglesey, for the last five years, passed on Saturday (June 4) into a new phase of its existence, and, it may be hoped, a more extended sphere of labour, when His Excellency Spencer Walpole, Lieutenant-Governor of the Isle of Man, declared the new marine laboratory at Port Erin to be open for work. The Puffin Island establishment has been very useful to the Committee, and well worth the small annual expenditure required for its modest outfit. It has been used by a few students who wished to gain a general knowledge of the common marine animals and plants in a living state, and by a limited number of specialists who went there to make observations, or who had the material for their investigations collected there and sent to them. But the Committee has felt for the last year, at least, that a station which was more readily accessible from Liverpool, and with hotel or lodging accommodation obtainable on the spot, would enable their members to do more work, and be of more use both to students and to investigators. Also, it was evident that after five years' work on the shores of the small island the greater number of the plants and animals had been collected and examined, and that a change to a new locality with a rich fauna and a more extended line of coast would yield increased material for faunistic work. On looking round the Liverpool Marine Biology Committee's district, Port Erin, at the southern end of the Isle of Man, at once presented itself as the best available place.

From its position, and the shape of the land, Port Erin has within a distance of a couple of miles in three directions—to Fleshwick Bay, to the Calf, and to Port St. Mary—a long and varied coast-line, with a number of small bays, furnishing good collecting-ground and shallow-water dredging. Two of these bays, Port Erin and Port St. Mary, have harbours with sailing-boats, and face in nearly opposite directions, so that in most winds one or other is sheltered and has a quiet sea. The rich fauna around the Calf and off Spanish Head is within easy reach: at a distance of three to four miles from the laboratory are depths of 20 to 30 fathoms, and at fourteen miles 60 to 70 fathoms. Although it is a considerable distance from Liverpool, still it is reached by a regular service of swift steamers and convenient trains, so that there is no uncertainty or delay in the journey.

The plan of Port Erin shows the position and surroundings of the Biological Station. It is on the beach at one corner of the bay, near where the sand and rocks join, and at the foot of the cliff upon which the Bellevue Hotel stands. It is connected with the road by means of a winding gravel path and steps, and is about a third of a mile from the railway station. It is just at the bottom of the hotel grounds, and arrangements have been made with the proprietor by which those working at the Biological Station can live comfortably and economically at the hotel. The sea comes to within a few yards of the windows, and the bay immediately in front is sheltered pure sea-water with a varied bottom, suitable for small boat dredging and tow-netting; while the rocky coast, extending out towards Bradda Head, has many creeks and good shore pools.

The station is a substantially built, three-roomed house, measuring a little over 30 feet by 20 feet, and standing on a solid stone and concrete platform, which raises it about 10 feet above high tide. It has windows looking out in three directions, north, south, and west. The front door leads into a passage, from which open to right and left two small rooms, which can be used as the Director's room and the Secretary's office, and will also be available for the use of members of the Committee, or any special students who require a separate room for their work. Opposite the entrance is the door into the main laboratory, which measures about 22 feet by 20 feet, and has windows on both sides. In front of the windows run strong fixed work-tables, which will accommodate five students with ease. At the ends of the room are fire-place, sink, tables, bookcase, and abundance of shelving, while along the centre runs a strong table for small aquaria and vessels containing animals. A door in one corner opens into a useful small yard between the house and the cliff, in which the concrete fresh water cistern is placed, and where dredges and other implements can be stored.



Plan of the Liverpool Marine Biological Laboratory at Port Erin. 1, Main laboratory (22 × 20), with work places for five students; 2, strong table for aquaria; 3 to 9, tables; 10, small laboratory for Director or members of Committee; 11, passage; 12, small laboratory or Secretary's office; 13, small yard.

The Liverpool Salvage Association had kindly promised to lend their useful steamer, the *Hyæna*, to the Committee for four or five days at the time of opening; but as she was called off on duty at the last moment, they sent the steamer *Mallard* instead, on Friday afternoon, across to Port Erin, where she remained until Monday. Dredging trips in the neighbourhood took place on three of the days, and on Saturday evening tow-netting with submarine electric lights was carried on after dark in the bay.

At one o'clock on Saturday the Lieutenant-Governor, the Bishop, the Manx Attorney-General, and a number of members of the House of Keys, and others, arrived at Port Erin, where they were met by Prof. Herdman, Mr. I. C. Thompson, Mr. A. O. Walker, Mr. J. Vicars, Sir James Poole, and others of the L.M.B.C., along with some biologists from elsewhere, the Liverpool party numbering over thirty. The Governor was conveyed to the front of the Biological Station, where, after being presented by Prof. Herdman with the reports upon the fauna of Liverpool Bay published by the L.M.B.C., he declared the building open for work, and then the party entered and proceeded to examine the results of the forenoon's dredging, laid out in dishes and under microscopes. At two o'clock the Governor and the Bishop were entertained to luncheon at the Bellevue Hotel by the L.M.B.C., Prof. Herdman being in the chair, with the Governor on the right and the Bishop on the left. Mr. I. C. Thompson, Hon. Sec. L.M.B.C., occupied the other end of the table, and about seventy in all sat down to luncheon, including the President and Secretary and some other members of the Isle of Man Natural History Society. The Governor proposed the toast of "The Liverpool Marine Biology Committee," to which Prof. Herdman replied.

The whole of the following day was spent in dredging and tow-netting from the *Mallard* to the west and south of Port Erin at the following localities:—

(1) 3 miles west of Fleshwick: 20 fathoms, 6 hauls of dredge: good varied ground, old shells, &c.

(2) 14 miles west of Dalby: 60 fathoms, 2 hauls; sticky clay mud, with few animals.

(3) 8 miles west of Fleshwick: 33 fathoms, 3 hauls.

(4) 6 miles west of Port Erin: 24 fathoms, 2 hauls.

(5) 1 mile west of Calf: 20 fathoms, 2 hauls.

(6) Off Kitterland, Calf Sound: 17 fathoms, 1 haul.

At each of these localities, besides the ordinary large dredge, tow-nets were used, and also Mr. Walker's small dredge with a canvas bag for bringing up samples of the bottom to be washed for small Crustacea, &c.

On the following day (June 6), on the way back to Liverpool, dredging from the *Mallard* was conducted at the following places:—

(1) 20 miles south-east from Port St. Mary: 26 fathoms.

(2) 25 miles south-east from Port St. Mary: 23 fathoms.

Both of these localities were good productive ground, and large hauls were obtained.

(3) 20 miles north-west from the Bar: 18 fathoms.

(4) 15 miles north-west from the Bar: 16 fathoms.

On all these occasions, besides the surface tow-nets, a bottom tow-net was attached a little way in front of the dredge, and appeared to work well; its contents were usually a good deal different from those of the surface nets.

Amongst the forms dredged in these two days were:—*Clathria seriata*, *Spongelia fragilis*, *Sarcodictyon catenata*, *Palmipes membranaceus*, *Stichaster roseus*, *Porania pulvillus*, *Antedon rosaceus*, *Adamsia palliata*, *Crania anomala*, *Pandora inæquivalvis*, *Cynthia echinata*, and the rare little Ascidian *Forbesella tessellata*, and a large number of other species, representing most of the invertebrate groups, which have not yet been sorted out and identified. A list of the species previously found in the neighbourhood of Port Erin will be found in "Fauna of Liverpool Bay," vol. i. pp. 318–41.

The Liverpool Marine Biology Committee's Station at Port Erin is now open, and is provided with a few microscopes, microtome, ordinary reagents, dishes, &c. Any biologists wishing to go there for collecting or other work are requested to apply for particulars to Prof. Herdman, or to Mr. I. C. Thompson, 4 Lord Street, Liverpool.

THE ANNUAL VISITATION OF THE GREENWICH OBSERVATORY.

THE report of the Astronomer-Royal to the Board of Visitors this year commences with a reference to the loss sustained by the Observatory by the death of Sir G. B. Airy, who for sixty years was closely connected with the working of this institution.

As regards the buildings, that of the south wing of the proposed Physical Observatory has been authorized by the Admiralty, considerably more space being required for the storing of chronometers and deck watches. The buildings of the three other wings and the two upper stories of the central tower have, for the present, been laid aside, sufficient provision not being made for them in the present financial year. The new 36-foot dome, which is being provided for the efficient working of the 28-inch refractor, is still in course of erection, while the pair of semi-domes for the Transit Pavilion in the Front Court has been found to be quite satisfactory. The electric light installation, which has in a former report been suggested by the Astronomer-Royal for the photographic equatorial and for other instruments, has been sanctioned by the Admiralty, and will, during the course of the present year, be provided. The advantages of such a means of lighting will at once make themselves apparent, for by the old method the storage cells had to be charged from primary batteries.

The Observatory, by the will of the late Sir George Airy, has had several valuable works bequeathed to it. Mr. Wilfred Airy has as yet transferred 94 volumes and 134 unbound tracts, which will form a valuable addition to the library, together with the manuscript containing the calculations of Sir George Airy's numerical lunar theory. His bust, by Foley, has also been received and is now placed in the Octagon Room.

With regard to the work done with the transit-circle, the number of observations was not so great as in former years, as the object-glass was removed for repolishing on August 10 to October 5. The definition and colour-correction of this glass has been greatly improved by Mr. Simms. New steel screws to the R.A. and Z.D. micrometers were added at the same time, and the wire system also received a slight modification. The wires are ten in number, distant from each other by exact multiples of a screw-revolution, and so arranged that the mean of the ten nearly coincides with one of them. A little computation is thus saved in taking the mean of a transit, and the only thing lost is symmetry in the arrangement.

During the rest of the year the sun, moon, and planets have been regularly observed on the meridian as before:—

Transits, the separate limbs being counted as separate observations	4801
Determinations of collimation error	249
Determinations of level error	335
Circle observations	4463
Determinations of nadir point (included in the number of circle observations)	319
Reflexion observations of stars (similarly included)	436

The annual catalogue of stars observed in 1891 contains 1813 stars.

The results from the observations for the determination of variation of personal equation with stellar magnitude, indicated that there was a general tendency with all the observers to observe stars later when the light was diminished by placing a gauze screen before the object-glass; but it was stated that "it is not clear that we are here measuring a real change of personal equation in observations of fainter stars, as the introduction of the screen modifies the image of the star, and this modification of the image may give rise to a change of personal equation unconnected with the diminution of brightness."

It is noted that as the external thermometer rises there is a nearly uniform decrease of the readings of the internal thermometers over that of the standard exterior thermometer, the excess vanishing at something over 70°. This is accounted for by the variation of the temperature of the walls of the room, the permanent temperature of which is always slowly changing.

The total number of observations made with the altazimuth in the year ending 1892 May 10 is as follows:—

Azimuths of the moon and stars	345
Azimuths of Mark I.	162
Azimuths of Mark II.	182
Zenith distances of the moon	166
Zenith distances of Mark I.	164
Zenith distances of Mark II.	176

These numbers are slightly greater than in recent years, owing to the fact that during August and September, when the transit-circle was under repair, the observations of the moon with the altazimuth were made throughout the lunation instead of being confined to the first and last quarters.

With regard to clocks and chronographs, we may mention that the daily rate of the sidereal standard clock underwent a very considerable disturbance, changing from a daily gain of 1·0s. to that of 2·0s. The cause of this difference was due to some workmen who were fixing a new shelf, the necessary hammering setting up vibrations in the building.

With the reflex zenith tube, eighteen double observations of γ Draconis have been made, but owing to the pressure of work the reductions are not yet complete.

Ten occultations of stars by the uneclipsed moon (8 disappearances and 2 reappearances) and 48 phenomena of Jupiter's satellites have been observed with the equatorials, or with the altazimuth. These observations are completely reduced to 1891 December 31. On the occasion of the partial eclipse of the moon on 1892 May 11, 7 disappearances and 3 reappearances were observed of the faint stars in a list prepared by Mr. Crommelin; and the times of transit of the shadow over some principal craters were also noted. But it is to be regretted that, although favoured by fine weather on this occasion, the Observatory was seriously crippled in their instrumental equipment, the 13-inch refractor of the south-east equatorial and the Lassell 2-feet reflector being both dismounted.

With the photographic equatorial, 301 plates with a total of 1190 exposures have been taken on 112 nights, many of these being taken for special investigations. Of these, 62 plates were taken to determine the relations between diameter of image, length of exposure, and brightness of the star, the results of which have already appeared in the *Monthly Notices* for January of this year. The discussion indicated that, through a range of exposures corresponding to 8 magnitudes, "the square root of the diameter increases as the logarithm of the exposure; and further, that for equal photographic effects duration of exposure should vary inversely as the brightness of the star." These results were based on as many as 2200 measures of 150 star images. The *réseaux* seem to have given much trouble, the silver film developing pin-holes, the images of which resemble on the photographic plates those of stars. M. Gautier is now supplying the Observatory with two more, coated this time with a film of collodion, in the hopes that it may be freed from the deficiencies mentioned above. The catalogue which has been undertaken at Greenwich of the guiding stars for the zones + 60° to the pole, + 25° to + 29°, and − 3° to − 5°, is very near completion. The catalogues of places (epoch 1900) are complete for the Greenwich zones + 65° to + 80° (the reductions for the circumpolar region being deferred), also for the zones + 60° to + 64° to be photographed at Rome, and for the Oxford zones + 25° to + 29°. The stars for the San Fernando zone (− 3° to − 5°) have all been selected, and their places have been computed for those between R.A. 12h. and 18h.

Spectroscopic and Photographic Observations.—The observations of the displacement of the lines in stellar spectra for the determination of their motion in the line of sight have not this year been regularly continued; a preliminary discussion of the former observations suggesting that they were affected to some extent by the position of the spectroscope, Vega and Altair were observed during the summer and autumn at as wide a range of hour-angle as possible, and with the spectroscope set to each of the four positions 0°, 90°, 180°, and 270°; the slit being parallel to the declination circle at 0°. The numbers of observations obtained of the F line in the spectrum of Vega are: at 0°, 39; at 90°, 42; at 180°, 36; and at 270°, 39; and of the F line in the spectrum of Altair: at 0°, 30; at 90°, 32; at 180°, 26; and at 270°, 29. The measures are now under discussion, and give clear indications of the existence of the systematic error referred to. The observations were interrupted by the dismounting of the 12¾-inch telescope on 1891 November 19.

At the appearance of the new star in Auriga the south-east equatorial was unfortunately dismounted, but the object-glass presented to the Observatory by Sir Henry Thompson was mounted as quickly as possible on the Thompson telescope; but alterations of the telescope tube were found necessary to bring the spectrum to focus on the photographic plate, and before these could be completed, the Nova had become nearly too faint for observation.

For the year 1891, 360 out of 365 photographs of the sun's surface have been selected for measurement; 136 of these were sent to the Solar Physics Committee from India and Mauritius.

The solar activity has increased in a remarkable manner during the past year. While there were 175 days without spots in the year 1890, there were only 21 such days in 1891, and since 1891 March 28, the sun has not been free from spots on a single day on which it has been observed. The number of groups visible on the disk at the same time, and their average size and complexity, have all greatly increased during the past twelve months, the group of February 5–18 being the largest ever photographed at Greenwich. This group has had an unusually long life, appearing first on 1891 November 15, and persisting till 1892 March 17.

Magnetic Observations.—The continuous register by photography of the magnetic elements has been satisfactorily maintained. It has been found that serious disturbances of the earth-current registers is due to the trains of the City and South London Electric Railway, situated at a distance of 2½ miles from the nearest earth plate, and about 4½ miles from the Observatory. The change of potential takes place every two or three minutes, varying in amount from "a small fraction of a volt to one-third of a volt or more."

The following are the principal results for the magnetic elements for 1891:—

Mean declination (approximate)	17° 23′ West.
Mean horizontal force ...	3·9587 (in British units). 1·8253 (in Metric units).
Mean dip	67° 19′ 49″ (by 9-inch needles). 67° 21′ 0″ (by 6-inch needles). 67° 23′ 22″ (by 3-inch needles).

In the year 1891 there were five days of great magnetic disturbance, but there were also about twenty other days of lesser disturbance, for which tracings of the photographic curves will be published; these days having been selected in concert with M. Mascart according to the arrangement mentioned in the last report. The calculation of diurnal inequalities from five typical quiet days in each month, commenced in 1889 at Prof. Rücker's suggestion, has been continued.

From February 13 to 14 a very large disturbance was recorded, commencing a day after the large sun-spot was on the central meridian. Considerable magnetic disturbances also occurred on March 6, 11, and 12. Other disturbances occurred on 1891 September 9, 1892 April 25–26 and May 1, and may perhaps "be connected with spots then on the sun's disk."

Meteorological Observations.—The mean temperature of the year 1891 was 48°·4, being 1°·1 below the average of the fifty years, 1841-1890. The highest air temperature in the shade was 85°·1 on July 17, and the lowest 12°·0 on January 10. The mean monthly temperature in 1891 was below the average in all months excepting June, September, October, December. In January it was below the average by 4°·4, in April and August by 3°·0, and in May by 2°·8.

The mean daily motion of the air in 1891 was 278 miles, being 4 miles below the average of the preceding twenty-four years. The greatest daily motion was 960 miles on December 10, and the least 34 miles on February 23 and 24. The greatest pressure registered was 31·5 lbs. on the square foot on November 11. On December 10 the pressure plate was not in action.

The number of hours of bright sunshine recorded during 1891 by the Campbell-Stokes sunshine instrument was 1222, which is about 66 hours below the average of the preceding fourteen years, after making allowance for difference of the indications with the Campbell and Campbell-Stokes instruments respectively. The aggregate number of hours during which the sun was above the horizon was 4454, so that the mean proportion of sunshine for the year was 0·274, constant sunshine being represented by 1.

The rainfall in 1891 was 25·0 inches, being 0·5 inches above the average of the preceding fifty years.

Chronometers, Time Signals, and Longitude Operations.—The number of chronometers and deck watches now being tested at the Observatory is 157 (91 box chronometers, 19 pocket chronometers, and 47 deck watches). The annual competitive trial of chronometers commences on July 2, and the trial of deck watches on October 22.

In the year ending 1891 May 10, the average daily number of chronometers and deck watches being regularly rated was 243, the total number received was 765, the total issued 750, and the number set to repair 442.

At the annual trial of chronometers the performance was good, the average trial number of the first six was 21·4, which compares favourably with those of previous years.

The dropping of the time-balls is next referred to. The Greenwich one was not raised on October 14, December 10 and 13, 1891, owing to the violence of the wind; on April 1, 1892, the springs of the mean solar clock failed to act, and on October 19 and November 22 failure in the connections was the cause.

The return signal from Deal was interrupted last November several times, owing to an accumulation of grease which had been applied to the piston. Signals from Devonport clock failed on 51 days, and those from the Westminster clock on 14 days.

The publication of the observations for the Paris-Greenwich longitude in 1888, and of those for the Dunkerque-Greenwich longitude in 1889, has been delayed pending a redetermination of the former longitude which was commenced on June 6 of the present year; and it is hoped to settle several questions of importance raised by the discussion of the results obtained in 1888.

The first stage of the operations for the longitudes Montreal-Canso-Waterville-Greenwich was completed on May 23. The time of transmission along the cable Waterville-Canso was about a quarter of a second—a result confirmed by a rough comparison of signals on 1892 May 11. Prof. McLeod, of Montreal, paid a similar preliminary visit to Canso in 1891 June, and found an accordant value for the time of transmission. Four portable transits were used for the time determinations. These latter were made in all on 14 nights at Greenwich, 12 at Waterville, and about the same number at Canso and Montreal. The preliminary reduction gives every promise of satisfactory accuracy at Greenwich and Waterville.

Captain Grant, R.E., has been at work at the Observatory practising the requisite transit observations for determining the boundary of Mashonaland.

In the Astronomer-Royal's general remarks at the conclusion of his report, he refers to a plan he has devised for making observations out of the meridian with a transit-circle. He proposes to have it so constructed that by means of a turn-table it can be placed and firmly fixed in certain definite azimuthal, the instrument "being used essentially as a transit-circle for a complete series of observations in the selected azimuths plane." This instrument, as he says, would advantageously replace the existing altazimuth, and could be used "not only for the important object of making extra-meridian observations of the moon but also for observations of the sun, planets, and stars (in the meridian as well as out of the meridian), for the elimination, as far as practicable, of systematic errors, and for the more accurate determination of astronomical constants." The aperture of the instrument he suggests should be 8 inches, with circles of 3 feet diameter, read by four microscopes, and he thinks that a suitable position for it could be found about 90 feet north of the declination magnet, where "an unobstructed view could be secured by mounting it with its axis at a height of about 20 feet above the ground."

NOTES.

THE Ladies' *Soirée* of the Royal Society is being held this evening as NATURE goes to press.

THE annual meeting of the American Association for the Advancement of Science will be held at Rochester, N.Y., from August 18 to 24.

THE late Dr. W. J. Walker placed at the disposal of the Boston Society of Natural History a grand honorary prize "for such investigation or discovery as may seem to deserve it, provided such investigation or discovery shall have been made known or published in the United States at least one year previous to the time of award." This prize has been unanimously awarded to Prof. James D. Dana. In recognition of the value of Prof. Dana's scientific work, and in testimony of the Society's high appreciation of his services to science, the maximum sum of one thousand dollars has been awarded.

IN the new number of the Journal of the Marine Biological Association Mr. Ernest W. L. Holt gives an interesting account of the work he has lately done in connection with his North Sea investigations. The objects of these investigations, as explained in the report of Mr. Calderwood, the Director of the Plymouth Laboratory, are:—(1) to prepare a history of the North Sea trawling grounds, comparing the present condition with the condition say twenty or thirty years ago, when comparatively few boats were at work; (2) to continue, verify, and extend operations as to the average sizes at which the various food-fishes become sexually mature; (3) to collect statistics as to the sizes of all the fish captured in the vicinity of the Dogger Banks and the region lying to the eastward, so that the number of immature fish annually captured may be estimated; (4) to make experiments with beam trawl nets of various meshes, with a view to determine the relation, if any, between size of mesh and size of fish taken. It is obvious that a considerable time must elapse before trustworthy data can be collected on all these points by one inquirer. Mr. Calderwood therefore notes that in Mr. Holt's early reports it has been thought advisable not to treat each heading in detail, since one season of the year may be more suitable for collecting information on one point than on another, but rather simply to state the results of work accomplished. During the spawning season most attention must necessarily be given to heading No. 2, so that in Mr. Holt's present report the relation of size to immaturity is principally mentioned. Work of a similar nature done by Mr. Holt himself in Ireland, by Dr. Fulton in Scotland,

and by observers at Plymouth, shows that a very considerable variation takes place in the sizes at which fishes become sexually mature in different localities, and Mr. Calderwood thinks it is probably not too much to say that as surely as legislation will have to be resorted to for the preservation of fish until they have spawned, so surely will the matter have to be studied for each coast separately.

MR. CALDERWOOD records in his report that the demand on the Plymouth Laboratory for specimens to be used in laboratories and museums throughout the country increases, and requires constant attention. The Laboratory can supply specimens which, in very many cases, could not otherwise be obtained. The proper preservation of certain classes of soft animals is in itself an art developed during the last fifteen years, almost entirely by the persevering efforts of Signor Lo Bianco, of Naples. Within the past year these methods have been published, and it is hoped that with practice the specimens sent out from the Plymouth Laboratory may gradually gain the character so long possessed by the Naples specimens alone.

AT the general monthly meeting of the Royal Institution on Monday, June 13, the special thanks of the members were returned for the following donations:—Mrs. Bloomfield Moore, £80, Sir David Salomons, Bart., £50, Mr. Charles Hawksley, £50, for carrying on investigations on liquid oxygen.

A COMMITTEE appointed by the Botanical Club of Washington to consider the questions of a botanical congress and botanical nomenclature has lately presented its report, which the Club has unanimously adopted. While favouring the final settlement of disputed questions by means of an international congress, the committee do not regard the present as an opportune time. They recommend the reference of the question of plant nomenclature first to a representative body of American botanists, and suggest the consideration, by such a body, of various questions. Among these questions are the following: the law of priority, an initial date for genera, an initial date for species, the principle "once a synonym always a synonym," what constitutes publication?, the form of ordinal and tribal names, and the method of citing authorities.

THE anticyclone, which at the time of our last issue had lain over these islands for some days, then began gradually to give way, and in the night of the 9th northerly winds and cloudy weather set in over Scotland, while depressions formed over England, causing thunderstorms in this country and in Ireland, with heavy rainfall in places, as much as 1·1 inch being measured at Mullaghmore during the twenty-four hours ending 8h. a.m. on Saturday, the 11th. These changes in the distribution of pressure caused great fluctuations of temperature; the maxima observed over Scotland on the 10th were in some cases as much as 30° lower than those of the previous day, while in England, on the 11th and 12th, a still larger decrease of temperature was experienced. A small depression which lay over the south-east of England on Sunday, caused a steady rain for some hours in that part of the country; the maximum temperature registered in London was 51°, being about 18° below the average maximum for June. In fact, so low a maximum temperature has not occurred in London, in June, for at least a quarter of a century. On the night of the 19th the temperature on the grass fell to 29° at Oxford. During the early part of the present week an anticyclone, lying to the westward, extended over the western and northern parts of the country, and a large depression appeared to the southward of these islands, causing moderate northerly and north-easterly breezes, while temperatures continued low in all parts of the country.

THE Meteorological Council have just issued, as the completing portion of the *Weekly Weather Report* for 1891, tables giving improved monthly and annual means of temperature, rainfall, and bright sunshine for all the stations (65 in number) used in the preparation of that publication. The large amount of labour expended on the calculations, and the trustworthiness of the values may be judged of from the fact that the temperature means extend over 20 years, the rainfall over 25 years, and the sunshine over 10 years. A glance at the figures at any station is sufficient to show the chief characteristics of its climate, as compared with any other locality. They show that London has the highest mean maximum temperature in July, 72°·4; Cambridge, the lowest mean minimum, 31°·6 in December, although several other stations have a mean minimum of 31°·7 in that month, and Cambridge and Hillington have 31°·7 and 31°·8 respectively in January. The wettest station is Laudale, N.B., with an annual rainfall of 79°·57 inches, and the driest, Spurn Head, 20·92 inches. The stations with most and least sunshine are Jersey and Glasgow respectively, the deficiency of the latter being due to smoke.

DR. J. HANN laid before the Academy of Sciences at Vienna, on May 5, another of those elaborate investigations for which he is so well-known, entitled "Further Researches into the Daily Oscillations of the Barometer." The first section of the work deals with a thorough analysis of the barometric oscillations on mountain summits and in valleys, for different seasons, for which he has calculated the daily harmonic constituents, and given a full description of the phenomena, showing how the amplitude of the single daily oscillation first decreases with increasing altitude, and then increases again with a higher elevation. The epochs of the phases are reversed at about 6000 feet above sea-level as compared with those on the plains. The minimum on the summits occurs about 6h. a.m., and in the valleys between 3h. and 4h. p.m. The double daily oscillation shows, in relation to its amplitude on the summits, nearly the normal decrease, in proportion to the decreasing pressure, but the epochs of the phases exhibit a retardation on the summits, of as much as one or two hours. In the tropics, however, this retardation is very small. He then endeavours to show that these modifications of the daily barometric range on mountain summits are generally explained by the differences of temperature in the lower strata of air. In connection with this part of the subject, he considers that even the differences in the daily oscillations at Greenwich and Kew are mostly explained by the different altitude of the two stations, and by the fact that Greenwich is on an open hill. In the second section he has computed the harmonic constants for a large number of stations not contained in his former treatise of a similar nature, including some valuable observations supplied by the Brazilian Telegraph Administration, and others at various remote parts of the globe.

A SECOND attempt is to be made to build an Observatory at the top of Mont Blanc. As the workmen who tunnelled last year through the snow just below the summit did not come upon rock, M. Janssen has decided that the building shall be erected on the frozen snow. A wooden cabin was put up, as an experiment, at the end of last summer, and in January and early in the spring it was found that no movement had occurred. According to the Lucerne correspondent of the *Times*, the Observatory is to be a wooden building 8 metres long and 4 metres wide, and consisting of two floors, each with two rooms. The lower floor, which is to be embedded in the snow, will be placed a the disposition of climbers and guides, and the upper floor reserved for the purposes of the Observatory. The roof, which is to be almost flat, will be furnished with a balustrade, running round it, together with a cupola for observations. The whole building will rest upon six powerful screw-jacks, so that the equilibrium may be restored if there be any displacement of the snow foundations. The building is now being made in Paris, and will shortly be brought in sections to Chamounix. The transport of the building from Chamounix to the summit of

Mont Blanc and its erection there have been intrusted to the charge of two capable guides—Frederick Payot and Jules Bossonay.

LECTURES on subjects of great practical interest are being delivered daily in connection with the International Horticultural Exhibition. Mr. H. Cheshire will lecture to-day on "Guano: its origin and composition, use and abuse." Among the subjects of other lectures for which arrangements have been made are "The relation of insects to flowers," "Strawberry culture," and "The tomato: its diseases," by Prof. F. L. Cheshire; "Hatching: the management of the brooding hen," by Mr. W. Cook; and "Plant food and the formation of composts," by Mr. H. Cheshire.

DR. W. L. ABBOT has prepared for the Smithsonian Institution an excellent descriptive catalogue of the collection of ethnographical objects from Kilima-Njaro, presented by him to the National Museum. Dr. Abbot expresses his belief that Kilima-Njaro, with its cool, healthy, and bracing climate, will some day be a great sanatorium for Europeans from the hot and fever-stricken coast regions. He would be sorry, however, to see civilization invade this region, and hopes the day may be far distant when a railway shall open the way into the interior, and drive off "the herds of game that still pasture within sight of Africa's great snow mountains."

MESSRS. JOSEPH BAER AND CO., booksellers, Frankfort, are selling the botanical library of the late Prof. L. Just, director of the botanical garden connected with the Polytechnicum at Carlsruhe. The list includes many important works in various departments of botanical science.

MR. L. RYBOT writes to us from Southampton that he caught a very perfect specimen of the rare crimson speckled *Deiopeia pulchella*, on the afternoon of Friday last (June 10), in a field on the right bank of the Itchen, not far from Southampton.

IN 1874 the British Association published a volume of "Notes and Queries on Anthropology," the object being to promote accurate anthropological observation on the part of travellers, and to enable those who were not anthropologists themselves to supply information wanted for the scientific study of anthropology at home. A second edition has long been wanted, and a Committee was appointed by the British Association to consider and report on the best means for bringing the volume up to the requirements of the present time. The Committee recommended that the work should be transferred to the Anthropological Institute, and this proposal was accepted, the Association making grants amounting to £70 to aid in defraying the cost of publication. The new edition has now been issued, the editors being Dr. J. G. Garson and Mr. C. H. Read; and every one who may have occasion to use it will find it thorough and most suggestive. The first part—Anthropography—has been entirely recast; the second part—Ethnography—has been revised, and additional chapters have been written. Among the contributors to the volume are Mr. F. Galton, Mr. A. W. Franks, Dr. E. B. Tylor, General Pitt-Rivers, and many other well-known authorities.

MR. CYRUS THOMAS announces in *Science*, of May 27, that he has discovered the key which will unlock the mystery of the Maya codices, and, probably, the Central American inscriptions. The progress of decipherment will be slow, but he is confident that it will be ultimately accomplished. He has already determined the signification of some dozens of characters, and in several instances ascertained the general sense of a group forming a sentence, although there are a number of conventional symbols. Mr. Thomas holds that the great majority of the characters are truly phonetic, and that the writing is of a higher grade than has hitherto been supposed.

THE members of the Johns Hopkins Marine Station accumulated during the summer of 1891, in addition to the results of their special researches, many general observations upon the fauna of Jamaica. These notes are printed in the April number of the Johns Hopkins University Circulars, and will be of considerable service to any one who may desire to obtain what is called in the Circular "a preliminary view of the material."

THE new number of the *Internationales Archiv für Ethnographie*, contains interesting notes (in English) by A. Ernst, Caracas, on some stone-yokes from Mexico. R. Parkinson contributes (in German) a paper on tattooing among the natives of the district Siarr, on the east coast of New Mecklenburg, New Ireland. A paper on the development and geographical distribution of the various types of building in use among Finnish peoples is contributed by Axel O. Heikel, of Helsingfors. The illustrations, as usual, have been carefully prepared.

THE Society for Promoting Christian Knowledge has issued a fresh series of coloured representations of plants. They have been printed in Germany, and ought to be of good service to students and teachers of botany.

THE first volume of "A Treatise on Hygiene," edited by Dr. Thomas Stevenson and Mr. Shirley F. Murphy, will shortly be issued by Messrs. J. and A. Churchill. It consists of articles, by eminent writers, on many different phases of hygienic science. The second volume is in the press.

MR. C. F. MABERY gives in *Science*, of May 13, a full account of the new chemical laboratory of the Case School of Applied Science, Cleveland, Ohio. In devising plans for the laboratory, Mr. Mabery felt that while it was not good economy to construct a building several times larger than present needs demanded, it was important to provide for the possibility of unlimited extension. A plain, rectangular form was therefore designed, and it was found that extension of the main hall into a wing of any size would not interfere with a convenient arrangement of the rooms for present use.

ICEBERGS seem to be unusually plentiful in the Atlantic this year. According to a writer in the *Times*, the log of the Inman liner *City of Berlin*, which arrived on the 3rd inst., shows how dangerously close to the Transatlantic path the icebergs are hovering. On the afternoon of May 31, about 5.45 o'clock, the *City of Berlin* was in latitude 50° 20′, longitude 42° 15′. It was a clear and pleasant evening, and almost all the passengers were on deck. About 5 o'clock the air became very chilly, and the temperature of the water was very low. Captain Land at once suspected icebergs, and steered a more southerly course in the hope of avoiding them. About 6 o'clock, only a few miles to the north, a towering double-pinnacled berg was sighted. The berg was fully 200 feet high and about 600 feet long. Twenty minutes later another berg was sighted on a direct line with the first; between 6 and 8.30 o'clock four bergs were sighted. None of them was less than 100 feet high and 300 feet long; all were in a good state of preservation, and looked as though they would be able to drift about for some time. Icebergs have also been sighted by other vessels.

THE Todas, inhabiting the Nilgiri plateau, are not dying out gradually, as has long been supposed. The last census figures show that they have increased by no less than 10 per cent. during the last ten years, there being now nearly eight hundred of them altogether.

IN the new number of the Journal of the Straits Branch of the Royal Asiatic Society there is an interesting note on the little insectivore, *Tupaia javanensis*. It is very common in Singapore, and especially in the Botanic Gardens, where it may be often seen running about among the trees. It is easily mistaken for the common little squirrel (*Sciurus hippurus*), of which it has much the appearance. When alarmed it quickly darts up the trunk of the nearest tree, but it is a poor climber, and never seems to go high up like the squirrel. Besides these points of resemblance, it appears to be largely frugivorous. It was found that the seeds sown in boxes were constantly being dug up and devoured by some animal, and traps baited with pieces of coco-nut or banana were set, and a number of tupaias were caught. These being put into a cage appear to live very comfortably upon bananas, pine-apple, rice, and other such things; refusing meat. The Rev. T. G. Wood, in his "Natural History," states that *T. ferruginea* is said to feed on beetles, but to vary its diet with certain fruits. The common species at Singapore seems to be almost entirely frugivorous, though its teeth are those of a typical insectivore.

THE thirtieth Bulletin of the Botanical Department, Jamaica, contains a careful paper, which ought be be very useful, on the sugar-cane borer, by which much damage is being done in sugar plantations. The author is Mr. T. D. A. Cockerell, Curator of the Institute of Jamaica. Another contributor to the Bulletin, writing of gardening in Jamaica, mentions that about a year ago Messrs. Cannel and Sons, Swanly, Kent, sent her some small plants of chrysanthemums by post. They were all new and valuable; and the English season being so short, Messrs. Cannel and Sons begged her to try whether she could succeed in getting seed from these for them, offering to send her a collection of choice chrysanthemums in repayment of her trouble should she be successful. Out of the six plants one died, killed by a grub; the rest turned out magnificent, blowing with a profusion such as she had seldom seen before—they were perfect umbrellas of bloom; but the flowers died off without seeding. The plants then threw out a perfect little forest of offsets, and she finds that any cuttings broken off from the old plants will root easily.

A METHOD of rabbit-destruction which has been tried with considerable success in the Hay district, is recommended by the *Agricultural Gazette of New South Wales* as worthy of the consideration of pastoralists throughout the colony, more especially where the rainfall is light. The destroying agent is poisoned water, which is prepared as follows:—Cover 1 ounce of strychnine with concentrated hydrochloric acid, or what is commonly known as strong muriatic acid or spirits of salts, and leave to soak all night. The mixture easily dissolves in half a gallon of boiling water. After making the solution, bottle off and use as required. A pint of the mixture will poison 60 gallons of cold water; possibly a weaker mixture might be efficacious. This system has been adopted at Benerembah Station, sixteen shallow 8- to 10-gallon troughs being used to each tank, and the number of rabbits poisoned at each tank nightly is stated to be 10,000. In the Mossgiel district no less than 27,000 rabbits were destroyed in two weeks by the use of poisoned water.

THE idea of flower-farming for perfumes seems to be exciting a good deal of interest in New South Wales, as many inquiries on the subject have lately been submitted to the Agricultural Department. There are at present in the colony no means of illustrating the practical operations of this industry, but the *Agricultural Gazette of New South Wales* hopes that this deficiency will soon be supplied by the institution of experimental plots on one or more of the experimental farms. The *Gazette* points out that in scent farms large quantities of waste material from nurseries, gardens, orchards, and ordinary farms might be profitably utilized, while occupation would be found for some who are unfit for hard manual labour. A Government perfume farm was lately established at Dunolly, in Victoria, and this promises to be remarkably successful.

AT the meeting of the Field Naturalists' Club of Victoria on March 14, Prof. Baldwin Spencer, the President, gave an interesting account of a trip he had made to Queensland in search of Ceratodus. Special interest attaches to this form, since it is the Australian representative of a small group of animals (the Dipnoi) which is intermediate between the fishes and the amphibia. Ceratodus has its home in the Mary and Burnett Rivers in Queensland, whilst its ally, Lepidosiren, is found in the Amazon, and another relative, Protopterus, flourishes in the waters of tropical Africa. Although unsuccessful in obtaining the eggs of Ceratodus, owing to the early season, Prof. Spencer was able, from a careful study of the surroundings under which the animal lives, to infer that its lung is of as great a service to it during the wet as during the dry season—a theory in direct opposition to the generally accepted one that the lung functions principally during the dry season, when the animal is inhabiting a mud-cocoon within the dry bed of the river.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. Oswald Norman; a Common Fox (*Canis vulpes*), British, presented by Mrs. Onslow Wakeford; two Four-horned Antelopes (*Tetraceros quadricornis* ♀ ♀) from India, presented by Mr. W. F. Sinclair; a Magellanic Goose (*Bernicla magellanica*) from the Falkland Islands, presented by the Rev. J. Chaloner; six Common Lizards (*Lacerta vivipara*), a Slowworm (*Anguis fragilis*), British, presented by Mr. Percy W. Farmborough; three Little Green-winged Doves (*Chalcophaps chrysochlora*) from North Queensland, deposited; two Diamond Snakes (*Morelia spilotes*), a Punctulated Tree Snake (*Dendrophis punctulatus*), a Bearded Lizard (*Amphibolurus barbatus*), a Burton's Lizard (*Lialis burtoni*) from Australia, received in exchange; a Great Kangaroo (*Macropus giganteus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE LATE NEW STAR IN AURIGA.—A very interesting table, showing a summary of all the observations made with regard to the magnitude of the late new star in Auriga, will be found in *L'Astronomie* for June. Commencing with the photographs taken by Prof. Pickering, when the Nova was very nearly of the 12th magnitude, the table shows a tremendous increase of brilliancy up to December 18, when it had reached a maximum, its magnitude then being about 4·5. From that date to March 2, the diminution in intensity was only very slight, being reduced only by about one magnitude, but, subsequent to this, the fading was nearly as rapid as the brightening, the star diminishing, on an average, a magnitude in a period of about 3·2 days.

PHOTOGRAPHIC MEASURES OF THE PLEIADES.—The third number of the "Contributions from the Observatory of Columbia College, New York," consists of the Rutherfurd photographic measures of the group of the Pleiades reduced by Mr. Harold Jacoby. These photographs were among the complete set of original negatives that were presented to this Observatory by Mr. Rutherfurd, and were taken in the years 1872 and 1874. This special group was chosen for reduction in order to investigate the accuracy obtainable by the methods employed, and the results show that the reduced places can be thoroughly relied upon. The table containing a catalogue of the stars in question gives the places for the epoch 1873·0, together with the precessional and secular variation. In the discussion of the results, the Yale and Königsberg heliometer measures have been used for the sake of comparison, and Mr. Jacoby clearly demonstrates that the photographic results are of very considerable accuracy. Taking the case of the right ascensions, the difference of the residuals, obtained from the Yale and New York results, and those from Yale and Königsberg, amounts in only two cases to as much as 0″·50, while the mean may be roughly estimated as less than 0″·25. That part of the table relating to the declinations furnishes equally satisfactory values, showing us that, for any future study regarding the determination of proper motions in this region, these photographic observations ought to be taken into account. The average probable errors in right ascension and declination amount to ± 0″·06 and ± 0″·05 respectively; the actual probable errors somewhat exceeding these values, as they involve the scale inaccuracies and other possible sources of error.

The Planet Mars.—In the early morning Mars is now visible on our eastern horizon. This period of 1892 will be the most favourable for observation that we have had since the year 1877. The opposition takes place on August 4 next, when the planet is near perihelion, so that its proximity to us will not be quite so great as was the case in 1877. The longitude of the planet at the time of its perihelion passage will be 333° 49′, but our earth will not reach this until August 27. The apparent diameter on the 18th of this month will amount to 17″·66, while on August 5 it will be 24″·78; the phases for these two dates will be respectively 1″·34 and 0″·05. The positions for the 17th, 21st, and 25th of this month are as ollows:—

June	R. A.	Decl.
17	21h. 16m.	−20° 4′
21	21h. 20m.	20° 7′
25	21h. 22m.	20° 13′

L'Astronomie for June contains a very interesting article by M. Camille Flammarion, in which some quite recent observations of this planet are inserted. There are also several illustrations of the physical features, including the new map by M. Lohse and the drawings made by M. Nieston during the year 1888.

GEOGRAPHICAL NOTES.

The French Ministry of Public Instruction has authorized M. Ch. Almand, of the Natural History Museum of Limoges, to study the Seychelles Islands in detail with special reference to their fauna.

The Geographical Society of Lima has just issued the last number of the first volume of its *Boletin*, a most creditable publication containing many articles bearing on the geography of Peru and the Andes. Amongst the more important papers in the current issue are a monograph on Lake Titicaca, a discussion of the climatology of Peru, by Dr. Luis Carranza, and the report of a recent Commission sent out by the Peruvian Government to inspect the new road across the Andes leading to the highest navigable point on the eastern rivers. The road starting from Chicla, the temporary terminus of the Oroya railway, crosses the watershed at Casapalca at 17,500 feet of elevation, passes Tarma, Palca, La Merced, and thence runs northward through a little-known region inhabited by native tribes to Puerto Tucker, at the junction of the Pichis with the navigable tributaries of the Ucayali. In referring to this road at a recent meeting of the Royal Geographical Society, the Peruvian Consul pointed out that it would be easy, if a railway were constructed following the line of this road, and connecting steamers run on the Amazon and Ucayali, to reach Lima from London in twenty days instead of a month as is now necessary. Other papers in the *Boletin* deal with the archæology of the Andes region; all branches of geography being well represented.

A new Russian Expedition to Eastern Tibet and Sze-chuan in China has been decided on, and will set out next year, under the leadership of M. Potanin. It is intended to spend three years in the exploration, a sum of 30,000 rubles (about £3000) being granted by the Russian Government towards the expenses. Capt. Roboroffski accompanies the expedition, on the staff of which various scientific specialists will also be placed.

At the May meeting of the Paris Société de Géographie the great gold medal was presented to M. Élisée Reclus for his "Nouvelle Géographie Universelle," a work which, though unfinished, is of unique value, and is respected and consulted in all countries. This award is significant of the feeling that careful and conscientious collation and generalization of the work of explorers and travellers occupies a much higher place in the science of geography than has been hitherto accorded it. Amongst those to whom other gold medals were awarded are the Prince of Monaco, for oceanographical research; M. A. Paine, for explorations in Indo-China; M. J. de Morgan, for travels in Persia and Kurdistan; M. H. Coudreau, for ten years of exploration in the interior of French Guiana; and M. Alfred Fourneau, for exploration in French Congo.

NAPLES ACADEMY OF SCIENCES.[1]

This volume has been much delayed on account of a memoir by Prof. Trinchese on *Rhodope veranii*. That paper should have constituted the first of the present volume, but a notice leaf after the title-page informs us that it will be sent later on as a separate pamphlet. In consequence the volume starts with an elaborate paper in French, of 72 pages and three plates, by M. S. Kantor, "Sur la solution canonique du problème des transformations birationnelles périodiques," iv.^{e} partie. This memoir treats of "Méthodes et problèmes; les caractéristiques internes et les caractéristiques permutables; les caractéristiques à 6, 7, 8 points; théorie arithmétique des caractéristiques de transformations birationnelles; les complex anallagmatiques de singularités et de la réductibilité des caractéristiques par équivalence birationnelles; les groupes impropres; les matrices birationnelles de M. de Jonquière; et sur plusieurs groupes de caractéristiques et de transformations."

Prof. F. Bassani contributes a paper on the Miocene Ichthyolites of Sardinia, from specimens collected and placed in his hands by Prof. Lovisato. The tables, cross references, and index are admirable, and of great use to specialists in this branch. Many of our English workers, and above all, Societies, should take a lesson from this. It is occasionally the author of a paper, but far more frequently the responsible authorities of some scientific body, that are the cause of such valuable details not appearing in a paper. How often does it occur that for a paltry economy, a valuable memoir is cast upon the world a dismembered trunk, little comprehensible to the reader, and often a curse to the writer, who is exposed to all sorts of absurd criticisms because his original statements have been pruned to deformed stumps and his tables entirely suppressed.

Several old species are more fully illustrated by descriptions and neat plates drawn by Mrs. Bassani, as well as a new species of Thyrsites, Thynnus, Lamna, Myliobatis, &c.

Prof. Eugenio Scacchi has a memoir on the crystallography of certain new salts obtained by Prof. F. Mauro. The fluoximolybdate of copper is found to be monoclinic. Hypofluoximolybdate of copper is also monoclinic, whilst the hypofluoximolybdate of zinc is rhombohedral. Observations were difficult on account of the great deliquescence of these salts. The memoir is accompanied by one plate of crystal drawings.

Dr. Otto Schmiedeknecht, on his return from an entomological excursion to the Ionian Islands, placed in the hands of Prof. A. Costa all the Tenthredinidæ and Cephina that he had collected there. Prof. Costa describes these under 68 species, 9 of which are new. This is followed by a new genus of Italian Tenthredinidæ, named Laurentia, represented by the species *Laurentia Craverii*. The third section of this "Miscellanea Entomologica" is constituted by the description of four species of Armenian Hymenoptera: *Hylotoma cyanura*, *Allantus violaceipennis*, *Lissonota ducalis*, and *Lissonota decorata*. The "Miscellanea Entomologica" terminates with a new African Blattid, the *Derocalymma Brunneriana*, and is illustrated by one plate of figures in black.

Prof. G. Nicolucci, in a "Glimpse at the Ethnology of Egypt," discusses the different theories concerning the origin of the ancient Egyptians. By comparing the results obtained from historical records, monuments, anatomical observations, and descriptions of the people by ancient writers, he concludes (1) that the Egyptians belong to a white family related in prehistoric times to a Semitic branch; (2) that their physical characters form a type apart, which is clearly revealed in the monuments and the skulls obtained from the tombs of all periods; (3) that this type is the purer the more remote is the period of the monuments; (4) that it is true the immigration of other people into Egypt modified in part the primitive type of the population, but that the principal part of the Egyptians have always retained their primitive characters; (5) at the present, although the type has been crossed by intermarriage with different people in the cities, and other points frequented by strangers, it retains its original character in the Fellah, who are the true and legitimate modern descendants of the constructors of the Pyramids.

Prof. Nicolucci considers the Copts to be descended from ancient Egyptians, but with some infiltration of negro blood. The paper is accompanied by two plates, one of several modern Egyptian types, and one of the portrait of Rameses II. side by side with that of a Fellah.

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[1] *Atti della Reale Accademia delle Scienze Fisiche e Matematiche di Napoli*, Serie Seconda, vol. iv., Napoli, 1891.

Signor G. F. Mazzarelli contributes some researches on the morphology and physiology of the glands of Bohadsch in the Aplysiidæ (the opaline gland of Vayssière). He also gives the diagnosis of a new species of Aplysia. The author gives an elaborate histological description of the organ illustrated by two coloured plates, and amongst other conclusions shows that three liquids are secreted—a white odoriferous, a violet, and a mucous—which he declares to have an important biological value, and to concur with the secretions of the mantle for the defence of the animal.

Dr. N. Terracciano in a note on some plants of the flora of Terra de Lavoro describes several species so far not met with in that district, others not included in the Italian flora, and some new species and varieties. Figures are given of *Arabis surculosa*, *Amaranthus crispus*, and *Kœleria collina*.

Next follows a monograph of the fossil Pristis, with a description of a new species (*Pristis lyceensis*) from the Miocene limestone of Lecce, and of course figured.

Dr. L. Manfredi has an interesting paper on the contamination of the street surface of large cities, from a hygienic and sanitary engineer's point of view, with special reference to Naples. Sweepings of the streets were made at 9 a.m.—that is, after the regular cleansing had been performed, so that the materials collected represented what remains all the day to contaminate the air and whatever objects it comes in contact with. The materials, collected with all due precautions, were submitted to bacteriological and chemical analysis. One gramme of fresh sweepings contains from 910·000 to 668,000,000 vital or living bacteria, or double the amount found in fresh fœces, or about 1319 times richer than drain water. Compared with the streets of Munich we find that the author there found 8000 to 12,840,000. He demonstrates that, so far as Naples goes, the more cleanly kept are the streets the lower is the number of bacteria in their sweepings, whilst they or their spores have great resisting powers to heat, sunlight, and desiccation. They are most abundant in the temperate seasons of spring and autumn; small rains increase them, torrents markedly diminish them. The Schizomycetes are the predominant type, but ferments and moulds are common. The chemical examination is equally interesting, and, as the author shows, the material is a most favourable culture medium for micro-organisms; which research leads up to a series of experiments to show how the number of these increase up to a certain date and then diminish in a given sample of sweepings; the effects of rain in facilitating this growth are demonstrated, and also the gases given off as the result of such changes.

The inoculation experiments are also not without interest. An examination of the sub-soil on the same lines is of great importance, and several practical and important conclusions are drawn from these researches, which the limits of space forbid our more fully reviewing. The memoir is one that should be consulted by every municipal officer.

Signor G. F. Mazzarelli has another long paper on the morphology and physiology of his favourite Aplysiæ of the Gulf of Naples, and illustrated by four plates.

Altogether this volume does credit to the Academy, but one regrets not to see papers by some more of its members.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—In a Convocation held on June 7, the thanks of the University were ordered to be conveyed to Mr. C. D. E. Fortnum, Hon. D.C.L., for his munificent gift to the Ashmolean Museum, and an indenture was sealed, the provisions of which place the Ashmolean Museum on an entirely new footing.

In the year 1888 Dr. Fortnum gave to the University a large portion of his collection of antiquities and works of art, which had been exhibited on loan in the upper room of the Ashmolean Museum. Dr. Fortnum has now notified his intention of bequeathing to the University the remainder of his collection together with his library, and he has undertaken to transfer to the University a sum of £10,000 on certain conditions, the main object of which is to provide for the care and maintenance of the Museum in the future. Under the indenture, which was signed on Tuesday last, the University is bound—

(1) To provide a sum, not exceeding £11,000, for the erection of a new Ashmolean Museum, on ground adjoining the University Galleries.

(2) To provide a sum, not exceeding £4000, for the fitting up and furnishing the Museum.

(3) To augment to £600 a year, at least, the income arising from Dr. Fortnum's benefaction of £10,000.

Dr. Fortnum's kindly intentions to the new Ashmolean Museum include a further bequest to the University of £5000 contingent upon the University voting the £15,000 for buildings, fitting, and furniture. With regard to this amount the University authorities make the following remark:—"Of the £11,000 required for the building, it appears that the Curators of the University Chest will have funds in hand in the course of this year and next, out of which this expenditure may be defrayed. It is right, however, to state that this will leave the University Chest for the present without further resources, in the form either of stock or of cash, for meeting any other new expenditure upon a large scale."

It is proposed that the old Ashmolean Museum, when no longer required for its present purpose, shall be available as an extension for the Bodleian Library, for which additional accommodation must have soon been provided.

The University Observatory.—The annual meeting of the Board of Visitors took place on Wednesday, June 8, when the Savilian Professor (Rev. C. Pritchard, D.D., F.R.S.) read his annual report. After remarking on the present condition of the buildings and instruments, the Professor said:—

"As anticipated in the last report, the work connected with stellar parallax is now complete, and I have placed upon the table a manuscript containing the result of that research. I need hardly say that it has been a work of unremitting labour, and one which has occupied the strenuous efforts of myself and the Observatory staff during the last four years. The manuscript thus completed consists of (1) the concise but complete history of all effective researches in stellar parallax up to the present date; (2) the results of the parallax work completed in this Observatory, extending on the whole to some thirty stars; (3) a catalogue of all parallactic determinations effected by other astronomers.

"The provision of photometric catalogues of stars of the ninth and eleventh magnitudes, within small specified areas for the use of the eighteen Observatories engaged on the international chart of the heavens, has been effected, and the results distributed through the agency of the Paris Observatory. The cause of this proceeding originated in the unsuccessful attempts to secure the required uniformity of stellar magnitude on the photographic plates by the employment of metallic gauze screens of one definite mesh. Much time was consumed on the experimental research into the action of such screens on the photographic image, and in the course of the inquiry certain unexpected and interesting results came to light, the substance of which I communicated to the Paris Academy, and which were subsequently published in the Transactions of that body. It is satisfactory to find that these photometric determinations have been appreciated and found to be of practical service, and have been acknowledged as such by both the Directors of the Greenwich and Paris Observatories.

"Notwithstanding these very serious interruptions, considerable progress has been made in securing the photographic plates for the international chart and catalogue. In number these plates amount to about 150, and it is hoped in future they will accumulate more rapidly, since the work on the preparation of these aforementioned photometric catalogues is now complete."

The report concludes with the usual acknowledgments to the assistants, and with this very satisfactory expression, on which we beg to congratulate the Savilian Professor—"The state of my health and other circumstances prevented my being present at the last meeting of the Board, but I am glad to say that the anticipation of the speedy and complete recovery, mentioned in the last report, has been fully realized."

Radcliffe Travelling Fellowship.—The Examiners for this Fellowship give notice that a Fellowship is thrown open this year to all persons who have been placed in the First Class in the School of Natural Science, without further restriction. The examination will be as far as possible in the subjects specified by the candidates who offer themselves for examination, and will take place in the first week in November.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 19.—"On the Measurement of the Magnetic Properties of Iron." By Thomas Gray, B.Sc., F.R.S.E. Communicated by Lord Kelvin, P.R.S.

This paper gives the method of experiment and results obtained in some investigations on the time-rate of rise of current in a circuit having large electromagnetic inertia. The experiments were made on a circuit containing the coils of a large electromagnet having laminated cores and pole pieces. The mean length of the iron circuit was about 250 cm., and its cross section 320 sq. cm. The magnetizing coil had 3840 turns, when all joined in series, and a resistance of 10·4 ohms. The coils were so arranged that they could be joined in a variety of ways so as to vary the resistance, inductive coefficient, &c., and also to allow the magnet to be used either as an open or a closed circuit transformer.

The electromotive force used in the experiments was obtained from a storage battery, and the method of experiment was to trace the curve, giving the relation of current to time, on a cronograph sheet.

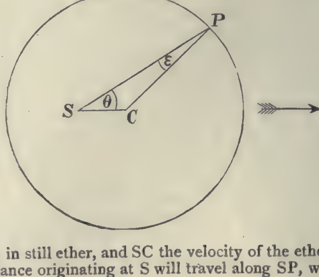
One set of experiments shows the effect of varying the impressed E.M.F. on the time required for the current to attain any given percentage of its maximum strength. The results show that for any particular percentage there is always a particular E.M.F. which takes maximum time. Thus for the circuit under consideration, and with successive repetitions of the current in the same direction, it takes longer time for the current produced by an impressed E.M.F. of 4 volts to reach 95 per cent. of its maximum than it takes for the current produced by either 3 or 5 volts to reach 95 per cent. of their maximum. The results show also that, within considerable limits, the time required for the current to become uniform is on the whole nearly inversely proportional to the impressed E.M.F., and that for moderate values of the E.M.F. the time may be very great; when the E.M.F. was 2 volts, and the current sent in such a direction as to reverse the magnetism left in the magnet by a previous current of the same strength, the time required for the current to establish itself was over three minutes. The difference of time required for repetition and for reversal of previous magnetization was also very marked when the iron circuit was closed. The results show that great errors may arise by the use of ballistic methods of experiment, especially when weak currents are used, and that for testing resistances of circuits containing electromagnets, a saving of time may be obtained by using a battery of considerable E.M.F.

Another set of experiments gives the effect of successive reversals of the impressed E.M.F. at sufficient intervals apart to allow the magnetization to be established in each direction before reversal began. In this set also the effect of cutting out the battery and leaving the magnet circuit closed is illustrated, showing that several minutes may be required for the magnet to lose its magnetism by dissipation of energy in the magnetizing coil. The effect on these cycles of leaving an air space in the iron circuit is also illustrated. It is shown that a comparatively small air space nearly eliminates the residual magnetism, and diminishes considerably the rate of variation of the coefficient of induction and the dissipation of energy in the magnet.

Several cycles are shown for the magnet used as a transformer with different loads on the secondary. The results give evidence that there is less energy dissipated in the iron the greater the load on the secondary of the transformer.

Some experiments are also quoted which go to show that the dissipation of energy due to magnetic retentiveness (magnetic hysteresis) is simply proportional to the total induction produced when the measurements are made by kinetic methods. Reference is made to the recent experiments of Alexander Siemens and others which seem to confirm this view.

Physical Society, May 27.—Mr. Walter Baily, Vice-President, in the chair.—The following communication was read:—On the present state of our knowledge of the connection between ether and matter: an historical summary, by Prof. O. J. Lodge, F.R.S. Referring to difficulties connected with the aberration of light, if the medium were supposed to be carried along by the earth in its orbit, Dr. Lodge described Boscovich's suggested experiment with a telescope filled with water, carried out by Klinkerfues, who was led to conclude that the aberration constant depended on the medium within the telescope. Klinkerfues's experiments were repeated by Sir G. B. Airy, but not confirmed. Astronomical observations were not necessary to determine the point at issue, for a fixed source near a collimator might be used with advantage. Hoek had examined the subject in this way with similar negative results. It might therefore be concluded that surveying operations are unaffected by terrestrial motion. This result, however, did not prove the existence or non-existence of an ether drift relative to the earth, for, since the source and receiver move together, any effect produced by such a drift would be compensated by aberration due to motion of the receiver. Speaking of refraction, he pointed out that, if the ether were stationary in space, glass and other terrestrial bodies would have ether streaming through them, and that the refraction of, say, glass might differ as the direction of the ether drift through it varied. To test this, Arago placed an achromatic prism over the object-glass of a telescope on a mural circle, and observed the altitude of stars. To vary the direction of the ether drift through the prisms, stars in different azimuths were observed; but the results showed no appreciable change in the deviation produced by the prism due to direction of the earth's motion. Maxwell used a spectroscope to test the same point. Light from illuminated cross wires passed through the telescope, prisms and collimator, and was reflected back along the same path by a mirror and viewed through the telescope. Observations made with different aspects of instrument showed no change in the relative positions of the wires and their images. Mascart had also tried the experiment with simpler apparatus, but was unable to detect any change. These observations naturally suggest that the ether is at rest relative to the earth, but the apparently simple nature of aberration makes this view difficult to hold. Both phenomena are consistent with Fresnel's hypothesis that only the excess of ether, which the substance possesses over that of surrounding space, moves with the body, for on this supposition the effects of altered refraction and ether drift compensate each other. Fresnel's view is practically established by Fizeau's well-known experiment on the effect of moving water on the velocity of light, and by the more accurate numerical results obtained by Michelson. The only other theory which accounts for the experimental results is one by Prof. J. J. Thomson, which requires that the velocity of light in Fizeau's experiment should be altered by half the velocity of the medium. For media whose refractive indices are $\sqrt{2}$, the two theories lead to the same result, and as the indices of substances such as water do not differ much from this value, it is difficult to discriminate between them. Looked at in another way, Fizeau's experiment raises a difficulty, for, as Dr. Lodge pointed out, all water is moving with the earth, hence light should be hurried or hindered according to the direction in which it passes through the water. This effect doubtless exists, but the results of it have never been detected by experiment. It is therefore necessary to inquire why the effect could not be observed directly, for the experiment had been tried with interference apparatus by Babinet, Hoek, Jamin, and Mascart, and in no case was any effect observed. It would therefore seem as if the ether must be stagnant, *i.e.* stationary relative to the earth. Mascart had also tested whether Newton's rings, or the rotary power of quartz, were affected by ether drift, but with negative results. These observations are, however, likewise compatible with Fresnel's hypothesis of an ether fixed relative to matter, and a free ether of space permeating all substances, for, according to this view, there is no more motion of the ether in water or glass than in air; hence the time of journey round a closed contour is independent of the direction in which the light traverses that contour. The time of journey between two points is also unaffected by terrestrial motion, as was proved by the experiments of Babinet, Hoek, and Mascart on interference; hence he (Dr. Lodge) inferred that ether was either stagnant or had a velocity potential. In moving ether it was necessary to define a ray, and Lorentz's method is the best. Suppose CP represents the velocity of light (V) in still ether, and SC the velocity of the ether (v), then a disturbance originating at S will travel along SP, which is the



direction of the ray, whilst CP is the wave normal. In the above figure,

$$\frac{\sin \epsilon}{\sin \theta} = \frac{\mathrm{SC}}{\mathrm{CP}} = \frac{v}{\mathrm{V}} = \alpha, \text{ the constant of aberration.}$$

The velocity along the path of the ray is SP. Calling this velocity V′, we have

$$\mathrm{V}' = \mathrm{V} \cos \epsilon + v \cos \theta.$$

The path of a ray is determined by the time of journey being a minimum, and the formula

$$\mathrm{T} = \int_{\mathrm{A}}^{\mathrm{B}} \frac{ds}{\mathrm{V}} = \text{a minimum},$$

is the equation to a ray, where A and B are the extremities, and *ds* an element of the path. If the ether be moving, V′ must be substituted for V, and we get—

$$\mathrm{T}' = \int_{\mathrm{A}}^{\mathrm{B}} \frac{ds}{\mathrm{V} \cos \epsilon + v \cos \theta} = \text{a minimum}.$$

This integral can be written exactly—

$$\mathrm{T}' = \int \frac{ds}{\mathrm{V}} \frac{\cos \theta}{1 - \alpha^2} - \int \frac{v \cos \theta}{\mathrm{V}^2(1 - \alpha^2)} ds$$
$$= \frac{\mathrm{T} \cos \theta}{1 - \alpha^2} - \int \frac{v}{\mathrm{V}^2} \cdot \frac{\cos \theta}{1 - \alpha^2} \cdot ds.$$

The last term is the only one involving the first power of ether drift, and it vanishes in case there is a velocity potential; for, since $v \cos \theta = \frac{d\phi}{ds}$, where ϕ is the velocity potential, it may be written $\frac{\phi_{\mathrm{B}} - \phi_{\mathrm{A}}}{\mathrm{V}^2(1 - \alpha^2)}$; and so its value depends only on the end points and not on the path. If these points are the same, *i.e.* the contour is closed, it becomes zero, and reconciles all the experiments hitherto made. It must be admitted, however, that if α is not a constant, the question is again opened, but there is no reason to suppose it can vary in the same horizontal plane. If the medium be changed, V becomes $\frac{\mathrm{V}}{\mu}$, and, in order to retain the same velocity potential in the changed medium, v must become $\frac{v}{\mu^2}$, which is Fresnel's law. Hence Prof. Lodge pointed out that the velocity potential condition includes Fresnel's law as a special case. It can, in general, be inferred that *no first order optical effect due to terrestrial motion can exist in a detectable form.* It is always compensated by something else. Quantities of the second order of magnitude must, therefore, be attended to. From the first equation above, it follows that

$$\cos \epsilon = \sqrt{1 - \alpha^2 \sin^2 \theta},$$

and the time of journey in moving ether is given by

$$\mathrm{T}' = \mathrm{T} \frac{\sqrt{1 - \alpha^2 \sin^2 \theta}}{1 - \alpha^2},$$

where T is the time if everything were stationary. This is, in brief, the theory of Michelson's recent experiment. If the light travels along the ether drift, $\theta = 0$ and $\mathrm{T}_1 = \frac{\mathrm{T}}{1 - \alpha^2}$; whilst if $\theta = 90°$, $\mathrm{T}' = \frac{\mathrm{T}}{\sqrt{1 - \alpha^2}}$. Therefore the velocity along the ether drift should differ from that across the drift in the ratio of $\sqrt{1 - \alpha^2} : 1$. This point has been very carefully tested by Michelson, but nothing approaching to a quarter of the theoretical effect was observed. His negative result would seem to preclude any relative motion, even irrotational, and shows that the ether is at rest relative to the earth's surface. On the other hand, the author (Dr. Lodge) had recently made experiments on the influence of rapidly-rotating steel disks on the ether, which prove that the ether is not affected by the motion of contiguous matter to the extent of 1/200 part of the velocity of the matter. Thus, these two experiments are at present in conflict. Prof. Fitzgerald has suggested a way out of the difficulty by supposing the size of bodies to be a function of their velocity through the ether. Returning to the statements which have been made of Fresnel's law, Glazebrook has shown that actual extra-density of ether is not necessary, for, if the virtual mass be altered, the same results follow; all that is required is a term depending on the relative acceleration of ether and matter. To modern ideas the loading of the ether by the presence of matter is most likely to be correct, and the observed effects of relative motion are regarded as the results of secondary reactions of matter on ether. On this view, the ether of space may be wholly unaffected by the motion of matter. On the vortex ring theory of matter, it is not unnatural to suppose that the ether in its neighbourhood should be only affected irrotationally by its motion. And if the velocity potential be granted, nothing of the nature of viscosity being admissible, the results of all the interference, refraction, and aberration experiments could be predicted, and the whole theory is as simple as it can possibly be. The only trustworthy experiment ever made which tends against this view is that of Michelson. The author surmised that this must somehow be explained away. In reply to a question from Prof. Ayrton, Dr. Lodge said that when air was substituted for water in Fizeau's experiment no effect was observed. This might have been expected, for the difference in the times of journey by the two paths depended on $\frac{\mu^2 - 1}{\mu^2}$, and as μ is nearly unity for air, the air effect is too small to see. [In Hoek's interference experiment it might be said that the effect of ether moving in stationary water is balanced by that of the ether moving in stationary air; but while motion of water itself would disturb the balance, motion of air would do nothing appreciable. The only kind of motion that could display an optical effect is rotational motion, or motion of layers at different speeds, not a simple uniform drift. Prof. J. V. Jones asked how the Fizeau experiment could be expressed on the loaded ether theory; for, since the speed of matter affects the velocity of light, it seemed to involve a directional loading. A mere extra-density term, or acceleration coefficient, will not explain this; it seems to require a coefficient of a velocity term. This question has been hinted at by Lord Rayleigh, who points out (under the heading "Aberration," NATURE, xlv. p. 499) that the rate of propagation of waves on a loaded string will be affected by a travelling of its load. The question is not perfectly simple, and the analogy not complete. A good deal depends on the nature of the connection symbolized as "loading."[1]]

Royal Microscopical Society, May 18.—Dr. R. Braithwaite, President, in the chair.—Mr. R. T. Lewis, in his paper on the process of oviposition as observed in a species of cattle tick, said that the tick was observed under a low power; after some time the head with the extended rostrum and palpi was retracted, producing a deep depression, the softer adjacent portions of the ventral surface between the basal joints of the first pair of legs being drawn over the margin. Parts surrounding the depression changed colour, and a white vesicle appeared upon the lower internal wall. The palpi separated, so that they rested on each side of the vesicle. A membranous body, glistening with mucus, was protruded from the cavity, from the lateral extremities of which two papillæ were thrown out, extending across the depression. The vesicle was then elongated and embraced by the papillæ; through its walls an egg was seen in motion, which, being delivered into the grasp of the papillæ, the ovipositor at once retracted. The papillæ closed round the egg, covering it with an albuminous secretion, and withdrew, leaving it suspended from the under surface of the dorsal plate. The palpi closed together until in contact with the rostrum, the head elevating, clearing the egg out of the depression, leaving it adhering to the outer margin: the entire process of laying each egg occupying a period of 2 min. 42 sec. Mr. A. D. Michael remarked that the word "head" was somewhat misleading, because these animals had no heads in the sense in which the term applied to insects, but the whole movable organ was really the rostrum.—Mr. E. M. Nelson read a note on penetration in the microscope, showing that for his own sight the penetrating power was only one-seventh of that given by Prof. Abbe, whose myopic sight accounted for the difference in the estimate.—Mr. Nelson also read a note on rings and brushes of crystals, for the observing of which a petrological microscope was generally thought to be necessary. This was not essential, as it was really a telescopic object. All that had to be done was to convert the microscope into a telescope by placing an objective inside the tube of the instrument.

Geological Society, May 25.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—On *Delphinognathus conocephalus* (Seeley) from the Middle Karoo Beds, Cape Colony, preserved in the South African Museum, Cape Town, by Prof. H. G. Seeley, F.R.S. The skull described in this paper is believed by Mr. T. Bain to have been collected by himself near Beaufort West. The preservation of the specimen leaves something to be desired, but notwithstanding defects the skull belongs to a most interesting Anomodont, indicating a new family of fossil Reptilia. The skull is fully described in the paper, and its relationships are discussed. The author has already given reasons for regarding *Ælurosaurus felinus*, *Lycosaurus curvimola*, and their allies, as referable to a suborder *Gennetotheria*, which is nearly related apparently to the *Pelycosauria*, and lies midway between the typical *Theriodontia* and the *Dicynodontia*. It is to this suborder that *Delphinognathus* may be referred, though it forms a family-type distinct from the *Ælurosauridæ*, distinguished by the conical parietal with a large foramen, the anterior supracondylar notch in the squamosal bone, and other modifications of the skull and teeth.—On further evidence of *Endothiodon bathystoma* (Owen) from Oude Kloof, in the Nieuwveldt Mountains, Cape Colony, by Prof. H. G. Seeley, F.R.S. Two bones found by Mr. T. Bain at Oude Kloof consist of the left ramus of the mandible and what the author regards as the left squamosal bone of *E. bathystoma*. The small cranial fragment preserved shows that the cerebral region probably conformed to the type of skull seen in some of the Dicynodonts. A description of the remains is given, and the author notices that the form of the articular condyle indicates a difference from *Dicynodontia* and all other *Anomodontia* hitherto described; it implies an oblique forward inclination of the quadrate bone—a character important in defining the suborder *Endothiodontia*. All the characters of the dentition of the animal suggest near affinity with the *Theriodontia*, especially the long lanceolate teeth strongly serrated.—On the discovery of Mammoth and other remains in Endsleigh Street, and on sections exposed in Endsleigh Gardens, Gordon Street, Gordon Square, and Tavistock Square, N.W., by Dr. Henry Hicks, F.R.S. In this paper the author gives a description of the deposits overlying the loam in which the remains of the Mammoth and other animals were found in Endsleigh Street, N.W. Under about six feet of made ground there was about ten feet of a yellowish-brown clay containing flints and much "race." Below the clay there was about five feet of sand and gravel, and under this about one foot of clayey loam, in which most of the bones were embedded. This loam contained many seeds, recognized by Mr. Clement Reid as being those of plants usually found in marshy places or ponds, and having a range at present from the Arctic Circle to the South of Europe. A list of the bones found is given by Mr. E. T. Newton, of the Museum of Practical Geology, Jermyn Street, who describes them as being those of one full-grown Mammoth, of another about half-grown, of the Red Deer, the fossil Horse, and of a small rodent. The author gives sections through Endsleigh Street and along the southern side of Endsleigh Gardens, and shows that where the bones were found there was a distinct valley in the London Clay, running in a direction nearly due north and south, the inclination of the valley being towards the north. The London Clay reached nearest to the surface towards St. Pancras Church and in Upper Woburn Place, the total thickness of the overlying deposits and the made ground there being only about 12 feet. Other sections, given along the southern sides of Tavistock and Gordon Squares, and through Gordon Street and the western side of Gordon Square, show varying thicknesses of the deposits, overlying the uneven floor of London Clay, of from 16 to 21 feet; the greatest thickness here is found at the north-western corner of Gordon Square. Seeds were also discovered in a loam near the bottom of Gordon Street, at the same horizon as that containing the mammalian remains, and some shells were found in a band of sandy clay, under a calcareous deposit, about half-way down the western side of Gordon Square. The author says that the deposits above the mammaliferous loam overlying the London Clay in this area cannot be classed as post-Glacial river-deposits, but must be considered as of Glacial origin. The animals, therefore, which evidently died on the old land-surface where their remains were found, lived there early in the Glacial period. The reading of this paper was followed by a discussion, in which the President, Mr. Monckton, Sir Henry Howorth, and the author took part.—The morphology of *Stephanoceras zigzag*, by S. S. Buckman.

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[1] Note by O. J. L.

Entomological Society, June 1.—R. McLachlan, F.R.S., Treasurer, in the chair.—The Hon. Walter Rothschild sent for exhibition *Neptis mimetica*, n.s., from Timor, mimicking *Andasena orope*, one of the Euplœidæ, and *Cynthia equicolor*, n.s., a species remarkable for the similarity of the two sexes, from the same locality; also a hybrid between *Saturnia carpini* and *S. pyri*, and specimens of *Callimorpha dominula*, var. *romanovii*, var. *italica*, and var. *donna*, bred by a collector at Zürich; he further exhibited a very large and interesting collection of Rhopalocera made by Mr. W. Doherty in Timor, Pura, Sumba, and other islands, during October and November 1891. Colonel Swinhoe remarked that the various species of *Neptis* were usually protected and imitated by other insects, and did not themselves mimic anything, and that the pattern of the *Neptis* in question was very common among the butterflies in the Timor group. Mr. Jenner Weir, Prof. Meldola, Mr. Trimen, and others continued the discussion.—M. A. Wailly exhibited fertile ova of *Trilocha varians*, which are arranged in small square cells, fastened together in large numbers, and present an appearance quite different from the usual type of Lepidopterous ova.—Mr. F. Merrifield exhibited a series of *Drepana falcataria*, half of which had been exposed for a week or two, in March or April, to a temperature of about 77°, and the other half had been allowed to emerge at the natural out-door temperature. The latter insects were in all cases darker than the former, all being equally healthy. Mr. McLachlan, Mr. Barrett, Mr. Jenner Weir, and others took part in the discussion which followed.—Mr. McLachlan called attention to the reappearance in large numbers of the Diamond-back Moth, *Plutella cruciferarum*, which was very abundant in gardens near London, and expressed his opinion that the moths had been bred in the country and had not immigrated.—Mr. Jenner Weir, Mr. Bower, and Prof. Meldola stated that they had recently seen specimens of *Colias edusa* in different localities near London.—The Hon. Walter Rothschild communicated a paper on two new species of *Pseudacræa*.

CAMBRIDGE.

Philosophical Society, May 30.—Prof. G. H. Darwin, President, in the chair.—The following communications were made:—The hypothesis of a liquid condition of the earth's interior considered in connection with Prof. Darwin's theory of the genesis of the moon, by Mr. Osmond Fisher. It was contended that a liquid condition of the earth's interior is not negatived by the existence of a semi-diurnal ocean tide, because it appears by calculation that a tide in an equatorial canal would in that case be diminished by only one-fifth of what its height would be upon a rigid earth. It was then recalled that all Prof. Darwin's numerical results in Table IV. of his paper on the precession of a viscous spheroid, as for instance that the moon was shed from the earth about 57 millions of years ago, depend upon the assumption of a certain high value for the internal viscosity, and will not hold good for a liquid interior. The total amount of heat, however, which must have been generated since that event, does not depend upon the viscosity, and will have been the same in the case of a liquid interior. This, if applied all at once, Prof. Darwin says, would raise the whole earth through 3000° F. if it had the specific heat of iron. Lord Kelvin holds that the earth is solid, and that it solidified in a short space of time, and that the matter of the interior at every depth is at the temperature of solidification for the pressure there. But if heat is being continually communicated to the interior, and chiefly to the more central regions, it seems impossible that the state of solidity supposed could be maintained. The author has shown in his "Physics of the Earth's Crust" that, if the crust is as thin as many geologists suppose, then there must exist convection currents in the interior, which prevent the crust from growing thick by melting off the bottom of it nearly as fast as it thickens. The central heat imparted to the interior by tidal action explains the maintenance of such currents. But the difficulty arises that the heat generated has been so great that there seems no obvious adequate mode of getting rid of it. The heat conducted away through the crust would not have been sufficient to reduce the mean temperature of the globe by more than about 209° F. in 100 million years from the first formation of a crust. Volcanic action on an extravagant estimate would help only to the extent of 4° or 5° F.; and the work of deformation of the crust would account for still less. It appears from the above that, if Prof. Darwin's theory is true, the solidification of the crust cannot have commenced until long after the birth of the moon; so that the still molten surface would be able for ages to radiate its heat directly into space. Otherwise we are thrown back on the nebular hypothesis, according to which the moon was left behind in the process of evolution of the system.—On Gynodiœcism in the Labiatæ, by Mr. J. C. Willis. Among the hermaphrodite flowers of *Origanum* and other Labiatæ, there occur (on the *same* plant) female flowers, and also flowers with one or more imperfect stamens; the corollas of these flowers are usually smaller than those of normal hermaphrodites. Their number varies from ·1 to 7·5 per cent. of the total flowers. Experiments conducted in 1891, to determine if these abnormalities varied in number with the season, gave no result; no two plants (though all were from one stock) gave similar results. Observations were also made on *Nepeta Glechoma*; the relative numbers of female and hermaphrodite flowers were determined weekly during the flowering season, and the proportion of females found to be greatest at the beginning of the season. It was also noticed that the female plants bear more open flowers at one time than the hermaphrodites (3·1 to 2·1). It was observed that the amount of protandry in the flowers appears to vary, being small at the beginning, and larger towards the end of the season. Further observations are in progress upon this subject.—On the steady motion and stability of dynamical systems, by Mr. A. B. Basset.—Note on the geometrical interpretation of the quaternion analysis, by Mr. J. Brill. The last two papers were taken as read.

DUBLIN.

Royal Dublin Society, May 18.—Dr. G. J. Stoney, F.R.S., Vice-President, in the chair.—Mr. G. H. Carpenter presented a report upon the Pycnogonida collected in Torres States by Prof. A. C. Haddon. The collection comprises only three species: *Pallene australiensis*, Hoek, for which (together with a new species) a new genus (*Parapallene*) is suggested; and a new *Ascorhynchus*.—Mr. H. H. Dixon gave a preliminary note on the mode of walking of some of the Arthropoda, illustrated by means of instantaneous photographs. He found that the limbs move together in "diagonals"; in insects the first and third legs on one side move with the second on the other; in spiders the first and third on one side with the second and fourth on the other; while the antenna of an insect is moved with the first leg on the same side.—Sir Howard Grubb, F.R.S., described his new chronograph for the Cape Town Observatory. This chronograph is built on the model of that at Dunsink Observatory, Dublin, with such improvements as have been suggested by recent developments in the clock-work of equatorial telescopes. The barrels, two in number, either or both of which can be brought into action, are 28 inches long and 9 inches in diameter. The screws which carry the wagons are one-tenth pitch, revolving once per minute. The circumference of the barrel being about 27 inches, the seconds are four-tenths of an inch long, and each barrel is available for about four and a half hours' work. The principal modifications upon the Dunsink instrument consist in the application of the electrical control of the clock, as described in the Proceedings of the Institution of Mechanical Engineers for the year 1888. The governor shaft of the clock gears directly into the driving spindle without any intermediate wheels, and as there is maintaining power to the clock barrel, it is possible to wind during the operation without at all affecting the rate of the clock. The axes of the barrels are supported upon sets of bicycle balls, in hardened steel boxes. The wagons carrying the electro-magnets for the registration of the signals are carried on one plain roller and two grooved rollers, the latter having hardened steel end-plates to insure accuracy of position. With the main instrument, which is inclosed in a glass case, is supplied a distributor for the purpose of working the electrical control, for the explanation of the action of which the above paper may be referred to.—On a new electrolytic galvanometer, by J. Joly. In the ordinary methods of determining the strength of a current by means of electro-chemical action, the element of time enters into the measurements, which further require considerable care in carrying out. In this instrument the observer is not concerned with time observations, and its indications follow fairly rapid variations of current. It consists of a glass bulb containing dilute sulphuric acid, in which are immersed platinum electrodes placed close together to diminish resistance. This vessel communicates below with a tube bent twice at right angles and carried up to a height of about 50 cm. above the level of the bulb. A little mercury contained in the bulb rises normally into this tube to a level which is the zero of the instrument. The tube is open at the top. The bulb is furnished with two tubulures on its upper surface. One is kept closed by a stopper, and merely serves to admit the electrolyte into the bulb when filling it. The other is furnished with a brass attachment upon which is cemented a small piece of platinum foil pierced by a hole of very small bore. The puncture is protected above and below from obstruction by receptacles containing cotton wool. When a current is passed between the electrodes the gas evolved can only escape through the fine puncture. At normal pressures this will only let the gas pass out slowly. Hence there is an accumulation of gas in the bulb, and the increased pressure causes the mercury to rise in the vertical index tube; but as the pressure rises, the rate of efflux of the gas increases till it equals the rate of evolution, when the mercury column comes to rest. The reading of a scale alongside the tube then gives the current in amperes. The instrument constructed for trial is very satisfactory. It reads on a very open scale up to 2·5 amperes. The electrodes are not large enough to carry heavier currents; if they were so, of course by enlarging the orifice the range could be increased. At the higher readings there is some delay before the mercury column becomes stationary, due probably to a rise of temperature in the bulb. There is probably some small variation of the readings with atmospheric temperature change. The calibration is effected by placing it in circuit with a trustworthy galvanometer. The inventor has had but little leisure to develop the instrument, and brings it before the Society in hopes that someone may think it worth while to further investigate its capabilities.

PARIS.

Academy of Sciences, June 7.—M. d'Abbadie in the chair.—On the application of M. Linstedt's method to the problem of three bodies, by M. H. Poincaré.—On a class of analytical functions of one variable, dependent on two real arbitrary constants, by M. Emile Picard.—On the products of the residual life of the tissues, especially of the muscular tissue separated from the living being, by MM. Gautier and Landi (continued). The authors found that meat when kept at a temperature not exceeding that of the living animal, acquired an acidity of about 0·5 per cent. after several weeks, during which it was protected from air and bacteria. They attribute this acidity to the formation of acid phosphate of potassium under the influence of fatty acids, and especially to the partial peptonization of the albuminoids. Two substances, found in milk, but not in fresh meat, are also abundantly produced, viz. casein and nucleo-albumin. The albuminoids steadily decrease, whereas there is a proportional increase of alkaloids, these being identical with those produced during the life of the organism.—Effects produced upon numerous morbid states by subcutaneous injections of a liquid extract from the testicles, by M. Brown-Séquard.—On the densities of liquefied gases and their saturated vapours, and on the constants of the critical point of carbonic acid, by M. E. H. Amagat.—On new methods of forming certain substitution imides, by M. A. Haller.—Reports of the Committee charged with the examination of the calculator Inaudi, by MM. Charcot and Darboux. Jacques Inaudi, a peasant born in Piedmont in 1867, learned to reckon before he acquired the art of reading and writing, which he did not master till twenty. He therefore owes his extraordinary calculating powers to an abnormally developed memory for figures, aided by a mental representation of numbers which the Committee proved by a series of careful experiments to be purely acoustical, and quite independent of visualization. The rules of Inaudi's operations are original. In addition and subtraction he begins on the left side, and deals with each whole number in its turn. The extraction of roots and the solution of equations are performed by tentative approximations, executed with remarkable rapidity. At the end of a long sitting Inaudi was able to recount the whole series of numbers dealt with, amounting to some 400 figures.—On the stability of motion in a particular case of the problem of three bodies, by by M. Coculesco.—Solar observations during the first quarter of the year 1892, by M. Tacchini. At the Roman College, during this period, the frequency of metallic eruptions, spots, and faculæ was greater in the southern hemisphere of the sun, whereas the protuberances were more frequent in the northern, and nearer the pole. The auroral maximum is probably more dependent on that of the protuberances than that of the sun-spots.—On a property common to three groups of two polygons, inscribed, circumscribed, or conjugate to one conic, by M. Paul Serret.—On discontinuous groups of non-linear substitutions with one variable, by M. Paul Painlevé.—On the acceleration of mortality in France, by M. Delauney. From a calculation based upon certain tables published by the Bureau des Longitudes, it appears that the death-rate is accelerated during the ages ranging from 16 to 32 and 54 to 82, while it is retarded between 1 and 16, 32 and 54, and after 82. This gives the numbers 16, 32, 54, and 82, which may be regarded as natural epochs of human life. They may be derived from the equation $3x^2 - 5x + 4$, by substituting for x the values 3, 4, 5, and 6. The equation represents a parabola.—Optical method of determining the conductivity of metallic bars, by M. Alphonse Berget. This is based upon an application of interference fringes or Newton's rings produced at the ends of two bars to be compared, by means of which the ratio of their elongations is found. Applicable to bars of rare metals.—On the propagation of heat within crystallized substances, by M. Ed. Jannettaz.—On a new determination of the ratio v between the electro-magnetic and the electrostatic C.G.S. units, by M. H. Abraham. Obtained by measuring the same capacity—of a plane condenser with guard ring—in both systems. The value obtained for v was $299{\cdot}2 \times 10^8$.—On the basic nitrates of zinc, by M. J. Riban.—On the permolybdates, by M. E. Péchard.—On a reproduction of leucite, by M. A. Duboin.—Contributions to the study of mineral waters: preservation of these waters, by M. P. Parmentier.—On the fixation of iodine by starch, by M. Gaston Rouvier.—Mechanical determination of the boiling-points of alcohols and acids, by M. G. Hinrichs.—Preparation and heat of formation of monosodic resorcin and hydroquinone, by M. de Forcrand.—Thermal study of the dibasic organic acids: methyl-malonic and methyl-succinic acids; influence of isomerism, by M. G. Massol.—On an oxidation product of starch, by M. P. Petit.—Organo-metallic combinations of the aromatic acetones, by MM. E. Louise and Perrier.—On the chlorine derivatives of the isobutylamines, by M. A. Berg.—Researches on the ptomaïnes in some infectious diseases, by M. A. B. Griffiths.—On the dioptase of the French Congo, by M. E. Lacroix.—Researches on the filtration of water by the Mollusca, and applications to ostreiculture and oceanography, by M. H. Viallanes.—On a parasite of the locusts, by M. L. Trabut.—Tuberculous vaccination of dogs, by MM. Héricourt and Ch. Richet. The effect was tried of vaccinating some dogs with aviary tuberculosis, which proved a perfect prophylactic to human tuberculosis, the injection of which proved fatal to those not so vaccinated, the rest being unaffected.

BERLIN.

Physiological Society, May 13.—Prof. Munk, President, in the chair.—Prof. Loewy gave an account of experiments on respiration under reduced atmospheric pressure, carried out in a confined space which admitted of very rapid reductions of pressure (to half an atmosphere) with constant composition of the inclosed air. The amount of reduction which was borne without ill effects differed in the case of the three persons on whom the experiments were made, in accordance with the magnitude of their respiratory activities: the greater the latter, the greater was the reduced pressure which could be withstood. For any one person it appeared that a greater reduction could be borne while fasting or during work than after a meal or during repose. Both oxygen and carbon dioxide were found to do away with the discomfort resulting from over rarefaction of the air. Slightly reduced pressure had no effect on respiratory interchange, while if the reduction was considerable, more carbon dioxide was expired, notwithstanding the diminished supply of oxygen. The reduced pressure of the latter gas was found to act on the respiratory mechanism in such a way as to lead to deeper, and hence compensatory, respiratory movements.—Dr. Wertheim spoke on the blood-vessels of the avian eye in both the embryonic and fully developed state, illustrating his remarks by injected specimens of embryonic eyes.

Physical Society, May 20.—Prof. Lampe, President, in the chair.—Prof. Neesen gave an account of his researches on the motion of loose disks centred on an axis rotating at high speeds. The disks were of varying mass and moment of inertia, and had at one side an excentrically-placed pin, in order that the least weight might be determined which, when applied to this pin, stopped the rotation of the disk. The necessary weight, as thus measured, was found to vary with the rotational velocity of the axis and with the mass and moment of inertia of the disk. It varied also according as the axis was dry or smeared with old or new oil, and also with the material of which the disk was made, &c.—Dr. Wien spoke on Maxwell's electro-magnetic theory, and the additions made to it by Poynting, and gave, in conclusion, a hypothetical conception of the nature of magnetism which corresponded to the existing formulæ.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Notes and Queries on Anthropology, second edition: edited by J. G. Garson and C. H. Read (Anthropological Institute).—The Birds of the Sandwich Islands, Part 3: S. B. Wilson and A. H. Evans, (Porter).—Irrigation and Water Storage in the Arid Regions; Letter from the Secretary of War (Washington).—Die Grundzüge der Theorie der Statistik: Prof. H. Westergaard (Jena, Fischer).—Die Bewegung der lebendigen Substanz: M. Verworn (Jena, Fischer).—Ostwald's Klassiker der Exakten Wissenschaften, Nos. 1 to 30 (Leipzig, Engelmann).—The Threshold of Science, second edition: Dr. C. R. A. Wright (Griffin).—Untersuchungen über mikroskopische Schäume und das Protoplasma: O. Bütschli (Leipzig, Engelmann).—Die Epiglottis: C. Gegenbaur (Leipzig, Engelmann).—Jethou, or Crusoe Life in the Channel Islands: E. R. Suffling (Jarrold).—Six Botanical Diagrams (S.P.C.K.).—Essays upon Heredity and Kindred Biological Subjects: Dr. A. Weismann; edited by E. B. Poulton and A. E. Shipley; vol. ii. (Oxford, Clarendon Press).

PAMPHLETS.—Present Problems in Evolution and Heredity: Prof. H. F. Osborn.—Church and State in Early Maryland: Dr. G. Petrie (Baltimore).

SERIALS.—Journal of the Marine Biological Association, vol. ii., No. 3 (Dulau.)—Proceedings of the American Philosophical Society, vol. xxx., No. 137 (Philadelphia).—Proceedings of the Academy of Natural Sciences, Philadelphia, 1892, Part i. (Philadelphia).—Transactions of the Leicester Literary and Philosophical Society, April (Leicester).—Rendiconto dell' Accademia delle Scienze Fisiche e Matematiche, January to March (Napoli).—Proceedings of the Royal Society of Victoria, vol. iv. (new series), Part i. (Williams and Norgate).

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THURSDAY, JUNE 23, 1892.

THE NEW LONDON UNIVERSITY.

IN our last issue we laid before our readers a statement of the proposals adopted by the Association for Promoting a Professorial University for London at a meeting held at Burlington House on the 14th inst. It may tend to clear the issue if we now briefly compare these proposals with the provisions of the Gresham Charter.

The Gresham Charter seeks to federate two Colleges and ten medical schools, primarily for examination purposes. Such a University, if created, would have had two competing staffs in the Faculties of Arts and Science and twelve in the Faculty of Medicine. Provision is also made, under certain conditions, for the federation of other institutions, if it can be shown to the satisfaction of the Council—that is, of the Chancellor, the Lord Mayor of London, and the representative members of the Councils of the two constituent Colleges and the ten medical schools—that such institutions are on a basis justifying the expectation of permanent existence; that they are under the independent control of their own governing bodies; and that they are reasonably well equipped in some one Faculty. Such a federation, created not primarily for the true business and proper functions of a University, but solely in the interests of a degree-granting body, could only have one result. The examination schedules must perforce be within reach of the lower grades of instruction, the various constituent elements would be actively competing bodies, and no attempt to create a single competent staff and a single set of fully-equipped University laboratories would be feasible. Is it at all probable that the true work of a University would flourish under such a system as that? Is it in the least degree likely that we could hope to see created in London, a teaching organization worthy of the greatest and richest capital in the world, or even such as many of the smaller European capitals now possess? The fame of a University, if it is to be anything more than a social function, must depend on the character of its teaching. Would the best men be attracted and retained by such a system? There can be only one answer to these questions. The Gresham scheme is not only a wholly inadequate solution of the University question, but in so far as it tends to accentuate and perpetuate the existing state of things its provisions are positively mischievous. No solution of the question can be either just or final which ignores the existence of the present University of London. If London is to have two degree-granting bodies existing, practically, side by side, we shall have confusion worse confounded. Burlington Gardens would inevitably be driven to establish a teaching organization of its own, unless it was supremely indifferent to its fate or supinely content with the teaching of the Correspondence Colleges and the crammers. Why should we neglect, and not only neglect but positively so arrange as to destroy, the prestige of the existing University of London? This University is not effete—it has still within it a great potentiality for good. Surely, in common gratitude, the University which has hitherto consistently upheld a high standard of attainment for its degrees, and which has done so much for the spread of natural science in this country, is worthy of better treatment at the hands of those who profess to minister to the true interests of learning. The Gresham scheme is really an attempt on the part of certain of the medical schools and some of the arts and science teachers to cheapen degrees and so attract students. It is true that the new University medical degrees would carry no license to practise. But is it likely that the University would permanently put up with this unique position, or that its students would continue to submit themselves without a murmur to a double examination system? As the document issued by the Victoria University indicates, the result, in all probability, would be to reduce the two examinations to a single standard by compromise with the licensing body. The scheme, moreover, gives an overwhelming preponderance to the most purely professional of all the faculties, and far too large a share of control to persons of small academic experience who devote occasional spare hours to academic affairs. It makes no attempt to satisfy the demand for the recognition in some form of University work among the people. No wonder, then, that it was strenuously opposed by a powerful section of the governing body, and by a majority of the teachers in the Faculties of Science and Arts, of the most influential College that it proposed to incorporate. The Council of University College, indeed, has never openly ventured to place the scheme before the governing body.

The Gresham University Commissioners are authorized by the terms of their reference "to consider and, if they think fit, to alter and to amend and extend the proposed charter, so as to form . . . a scheme for the establishment, under charter, of an efficient teaching University for London." It is impossible to conceive how the charter submitted to them can be amended so as to form such a scheme if its salient features are preserved. That fact is becoming more and more patent every day. The Association which put forward the proposals we have already referred to now numbers among its members—medicine excepted—a majority of the leading London teachers. If these teachers say that they do not wish the Gresham Charter at any price, it is difficult to see how it can be imposed upon them. Any attempt to resuscitate that charter, even with amendments, will meet, as before, with the opposition of the provincial Colleges, the minor London teaching bodies, and, what is perhaps more important, the organized opposition of a large section of the London teachers, and of some of the most powerful and influential friends of higher education in this country.

The fact is that it is at last clearly recognized that the foundation of a Metropolitan University, which will bear comparison with those of the great Continental cities, is a matter of national importance. The action of the House of Commons with regard to the Gresham Charter offers an opportunity, such as may not soon occur again, for attempting the formation of a University in London on the same ample lines as those to be found in other European capitals. Watchful observers of what has been going on during the past three or four years have deliberately come to the conclusion that it is quite impossible to improve the condition of higher education in London by means of any federation of Colleges. The creation of a homogeneous academic body with power to *absorb*, not to federate, existing institutions of academic rank, is the only real solution of the problem. An academic body of this character might well be organized, so far as teaching is concerned, on the broad lines of a Scottish University. Such a corporation may be conveniently spoken of as a *professorial University*, to distinguish it from a federal University. A federal University may be all that is possible when the constituent Colleges are situated in different towns, as is the case in the Victoria University; but it cannot be efficient in London, where these Colleges would appeal to the same public for support.

The scheme put forward by the Association for Promoting a Professorial University for London is not open to the objections urged against the Gresham scheme. It would found a University on the same broad lines as those of France, Germany, and Switzerland. It would bring to the new University all the power and prestige of the existing University. It will meet with no opposition from the provincial Colleges; on the contrary, it has the active support of many of the leading provincial teachers. It satisfies the demands of the Victoria University that the medical degree shall carry the license to practise, and that the medical representation shall not preponderate. It has, for the first time in the history of the movement, brought the most influential teachers from a variety of London teaching bodies into close and active sympathy, and animated them with a desire for a University of definite type. It is significant that the Council and staff of Bedford College are at one in favour of a University on the general lines laid down in the Association scheme. The Senate of University College has carried a motion urging their Council to adopt a similar resolution in favour of the scheme of absorption. The Association scheme makes full provision for the recognition of work of the University Extension character, and for the appointment of University lecturers at minor and non-absorbed teaching institutions. Whilst proposing central control and central University laboratories of the highest type, it provides for local teaching such as is required for pass degrees or for the lower stages of honours graduation. Lastly, it provides for post-graduation courses and specialized instruction, such as that of the Collège de France and of the greater German Universities.

As regards medicine, it recognizes that it is impossible to "absorb" the medical schools owing to their close relation to great public charities; but at the same time it endeavours to grant much of what the Medical Faculty gained by the Gresham Charter. The Medical Faculty will be elected by the medical teachers themselves. There will be, as in every University of standing, medical professors appointed by the Senate from the Medical Faculty on the recommendation of the faculty. The existence of such a medical professoriate will enhance the dignity of the University and of the medical schools, whilst at the same time it holds out a strong inducement to those schools to select members for the Medical Faculty on the ground of their scientific as well as their administrative reputation. The limitation of the number of medical professors on the Senate will safeguard the character of the medical degree. The scheme, whilst giving very extended powers to the medical schools, meets the objections of the provincial opponents of the Gresham Charter. Lastly, it provides for the due University recognition of the pure science teaching of the medical schools.

We have thus indicated as shortly as possible the main features of the two schemes which are at present before us. The one is essentially parochial in its conception, and vestry-like in its character. The other has in it the elements of a great teaching organization which shall be both metropolitan and imperial in its aims and influence—a University which shall be worthy of London, the capital alike of Great Britain and of the Greater Britain beyond the seas.

THE ANALYSIS OF WINES.

Analyse des Vins. Par le Dr. L. Magnier de la Source. (Paris: Gauthier-Villars et Fils, 1892.)

ALTHOUGH wine is gradually becoming more and more important as an item in the national drink-bill—last year we imported 16,782,038 gallons, valued at £5,995,133—its analysis and the methods for the detection of its sophistication have received comparatively little attention from the chemists of this country. On the other hand, in France and Germany the subject has been very thoroughly investigated in practically all its many details, and carefully worked-out methods have been prescribed for the guidance of the public analysts of those countries. Indeed, there is probably no article of food or drink, with the possible exception of milk, of which the chemistry has been so well thrashed out. Wine is in reality a highly complex fluid, and on account of the character of certain of its proximate constituents it is frequently liable to change. It contains various alcohols, glycerin, acids, salts, "extractive matter," together with those principles which give to it its particular colour, special flavour, smell, or "bouquet." Whilst some of these constituents can be accurately isolated and described, others can only be detected by the sense of smell. The principal alcohol is, of course, ethyl alcohol, but butyl and amyl alcohols, together with ethylene glycol and isobutyl glycol are not unfrequently present in greater or less quantity. The quantity of alcohol in natural wines may be said to vary from 6 to 12 per cent., and the quantity of glycerin from 7 to 10 per cent. of the alcohol present. Tartaric, malic, succinic, glycollic, and oxalic, together with tannic and acetic, are the chief acids in wine. These are said to aid in its preservation, by preventing the formation of fungi. Traces of other fatty acids, such as propionic, butyric, and œnanthic acids are also present, as well as acetaldehyde, and possibly its homologues. Tartaric acid occurs mainly as the dextro variety: lævo-tartaric acid is only of comparatively infrequent occurrence. If tartaric acid is not found, as, for example, in certain samples of sherry, its absence is almost certainly due to its removal by "plastering." The amount of free acid in sound wine, reckoned as tartaric acid, varies between 0·3 and 0·7 per cent.; a greater amount than this imparts sourness to the wine.

Old wines have an acid reaction in consequence of the presence of a certain amount of free acid and potassium bitartrate. A wine not exhibiting this acid reaction tastes flat; the acidity is its most important flavour. For a long time it has been believed that the free acid of wine is tartaric acid alone. Nessler's researches have, however, shown that this is seldom the case; tartaric and malic acids often exist together, and frequently the free acid consists of malic acid entirely. Wines containing tartaric acid taste more tart than those with only malic acid, or a mixture of malic and tartaric acids.

The characteristic smell of wine is said to be due to œnanthic ether; the compound ethers probably confer the bouquets which distinguish one vintage from another: among these are aceto-propylic, butylic, amylic, caprylic, butyro-ethylic, caprylo-ethylic, capro-ethylic, and pelargo-ethylic, and the tartaric ethers. According to Jacquemin, these bouquets are primarily due to the special characters of the yeast used in the several districts. One and the same "must" fermented with the yeast obtained from several different districts gave wines having the bouquet characteristic of the district from which the particular yeast had come. Rommer fermented the juice of an inferior grape and of hot-house grapes respectively with yeast cultures obtained from the Champagne, Côte d'Or, and Buxy districts, and found that in each case the wines had the bouquet of those from which the yeast had been derived. The sugars occurring in wine are dextrose and lævulose. Cane-sugar is never naturally present, even in "must"; it is sometimes added, as in the case of champagne, but it is then rapidly transformed into invert sugar. In some wines, as, *e.g.*, Sauternes and sweet Rhine wines, sugar occurs in the form of inosite. The colouring-matter of normal wine is derived partly from the oxidation of the so-called extractives contained in the juice, and in the case of red wines from matter (œnolin or œnotannin) contained in the husks, stalks, and seeds, which is soluble only by the joint action of acid and the alcohol formed during fermentation. The albuminous substances in the "must" are removed when the fermentation is properly carried out, but in imperfectly fermented wines a certain amount remains, and in the case of white wines may again render them liable to fresh fermentation. In red wines this danger is obviated by the presence of the tannin of the husks.

The inorganic substances contained in wine are potash, soda, lime, and magnesia, in combination mainly with tartaric, phosphoric, and hydrochloric acids. Sherries contain potassium sulphate in excess, owing to the practice of adding gypsum to the "must." This practice, which prevails not only in Spain, but also in Portugal, the south of France, and to some extent in Italy, probably has for its object the precipitation of certain albuminous matters which injuriously affect the wine. It is alleged that the fermentation is in consequence much more rapid and complete, that the wine keeps longer, and that its colour is richer and more lasting. Its real advantage to the wine-maker is that it clarifies the wine rapidly, and allows it to be quickly brought to market. It is chiefly employed with the coarser qualities of red wine, and the gypsum is either added to the grapes and trodden with them, or, in fewer cases, added to the expressed juice; the quantity used is generally 1 to 2 kilos to every 100 kilos of fruit, but it is some times as much as 10 kilos. The action of the calcium sulphate on the bitartrate of potash present in the juice produces an acid sulphate of potash, which gradually forms the normal salt by decomposition of the phosphate present forming free phosphoric acid. Hence a "plastered" wine is relatively rich in potash and sulphuric acid.

Although much has been said as to the baneful effects of plastered wine, very few trustworthy cases of injurious action have been recorded. The Academy of Medicine of Limoges instituted a lengthened inquiry on the subject in 1888, and reported unfavourably on the effects of plastered wine upon health. The French War Department also appointed a Commission, and its conclusions, which, on the whole, were unfavourable to the practice, have been recently confirmed by Nencki, who was requested by the Government of the Canton Berne to report on the advisability of modifying a law, which operates in many parts of the Continent, forbidding the sale of wines containing more than 2 grams of potassium sulphate to the litre. As to the question whether a plastered wine should be called adulterated, it has been contended that a product which, by treatment, is deprived of one of its most characteristic constituents, viz. tartaric acid, whilst another substance, calcium sulphate, not normally present, is introduced, cannot be called anything but adulterated.

As may be supposed, the art of the falsifier is very largely directed to the improvement of the colour of wine; and unfortunately it is upon the product which popular prejudice associates with the name of an eminent statesman, and which has no other attribute of claret than its colour, that his skill is mainly expended. It has been estimated that the whole yield of the "classed growths" of the Médoc does not, even in the best years, now exceed 5,000,000 bottles. Much of this, it is true, comes to England, but enormous quantities of *paysan*, *artisan*, and *bourgeois* wines from the Gironde and Languedoc, mixed with the produce of North Spain and Italy, are worked up and sold as "claret" in this country. This product is not exactly poisonous, nor even, as a rule, positively hurtful, but, it need hardly be said, it has no special merit or individuality. Formerly, the pharmacopœia of the wine-doctor, like that of the physician of old, was restricted to products of the vegetable kingdom; but, in addition to the colouring-matter of *Phytolacca* berries, *Althæa rosea*, bilberries, mallow, elderberries, privet-berries, logwood, alkanna red, lichen reds, all of which are still used to a greater or less extent, he has not been unmindful of the wealth of colouring-matter which is latent in coal-tar; and to-day the banks of the Rhine have their part in the manufacture of other wines than hock. Biebrich scarlet, fuchsine (magenta), the various Ponceaus, Bordeaux reds, crocein scarlet, and similar colouring-matters, find their way to the south of Europe for the purpose of wine sophistication. A substance known as *tintura per los vinos* is largely used in the district of Huesca for colouring Spanish wines. It contains two coal-tar derivatives, one of which is that form of Biebrich red which is turned blue by sulphuric acid, whilst the other, which exists in smaller proportion, closely resembles the colouring matter known as *cerise.* According to an analysis by Jay, the composition of *tintura* is: organic matter, mainly Biebrich red, 66·4; sodium sulphate, 26·10; arsenious oxide, 1·62; iron oxide, lime, &c., 5·88. In view of the peculiar nature of this substance, it is reassuring to know that there is a tendency to return to vegetable colouring-matters, and that large quantities of maqui berries are being imported into Europe from Chili for the purpose of colouring wines. In the three years ending 1887 the exports of this substance were respectively 26,592, 136,026, and 431,392 kilos, by far the largest proportion finding its way to France.

The little book before us has no pretensions to be regarded as a complete treatise on the analysis of wines. Its aim is to furnish the analyst with a number of carefully tested methods for the detection of sophistications and adulterations, and for the rapid determination of those constituents on which the character of wine mainly depends. Dr. Magnier de la Source is well known in France as an authority on the subject, and the *Bulletin* of the French Chemical Society contains papers by him relating to the analysis of wine. His methods are, for the most part, similar to those adopted by the Association of German and Austrian analysts, although they are not described with that minute attention to detail which has been found desirable by the German-speaking chemists. As may be seen on turning over the pages of Fresenius's *Zeitschrift für analytische Chemie*, the "musts" and wines of Germany are periodically examined and reported upon with all the method and regularity adopted in the case of the London water-supply; and it has happened in the past that the modes of determining such constituents as the vegetable acids, glycerin, and "extractive matters" have been discussed and wrangled over in a manner which recalls the famous fights over "organic carbon," "albuminoid ammonia," and "previous sewage contamination" of years ago. The only fault that we have to find with this book is that its author hardly does justice to his German brethren; although, it is but fair to add, some reference to their work is to be found in the excellent bibliography at the end of the volume. T. E. T.

MODERN THERAPEUTICS.

An Introduction to Modern Therapeutics. By T. Lauder Brunton, M.D., &c. (London: Macmillan and Co., 1892.)

THIS work is a reprint of the Croonian Lectures delivered before the Royal College of Physicians, London, in 1889. Whatever Dr. Brunton writes is sure to be interesting, and the present lectures have lost none of their lucidity or freshness though three years have elapsed since they were before the medical profession. It is hardly necessary to say that the subject is one with which Dr. Lauder Brunton is eminently fitted to deal, and the non-medical reader will be convinced when he has read the volume that medicine and therapeutics are far from being the inexact sciences they were not many years ago. The elementary nature of some of the early pages will be understood when it is remembered that the audience before which the lectures were originally given consisted in a large measure of men who had learnt chemistry before the days of Crookes, Lockyer, and Mendeleeff. It was necessary that the author should lead them through a brief survey of the chief facts and theories relating to atoms and molecules until the more difficult subject of the composition, constitution, and methods of union of organic radicles is reached. This is done in an admirably clear summary, assisted by those apt illustrations drawn from every-day life for which Dr. Brunton is so well-known. Our new drugs are now made by the chemist; so great has been the advance of organic chemistry, that the pharmacologist has hard work to keep pace with all the new combinations that issue from the laboratory. But the two classes of investigators, the chemists and the experimental therapeutists, have at least gone hand in hand so far, that it is now possible to judge the action of a drug by its composition. This, however, as Dr. Brunton points out, is not a rule without exception. There are many drugs which behave in unexpected ways; they no doubt, in the future, will be brought into harmony with laws of nature yet to be discovered. At present it is not possible to prophesy the physiological action of a chemical compound with that mathematical accuracy which enables astronomers to foretell eclipses; pharmacology is yet, and perhaps always will be, an experimental science.

The lectures stand practically in the same condition as that in which they were delivered. A volume of equal size to that under consideration would have been necessary to include all the new work that has appeared in the last few years. The tuberculin of Koch; the importance of poisonous proteids, and the diminishing popularity of the ptomaines; the action of the intestinal epithelium (*vice* the liver) as the gatekeeper protecting the body from the entrance of albumose; the application of phagocytosis to the problems of disease, together with the views of the antiphagocytists—these are a few of the big questions that have come to the fore in the last three years, and it is only active pathologists who would be able to realize how much longer these lectures would have been if full reference had been made to all of them. The main facts, and the principal conclusions adduced by Dr. Brunton, will, however, still remain; and all those who read the lectures in the medical journals before will welcome their appearance in a more permanent form now, and to those who missed them in 1889 we can confidently recommend the book as one which will not only be interesting but also useful. W. D. H.

OUR BOOK SHELF.

Elementary Hydrostatics. By W. H. Besant, Sc.D., F.R.S. "Cambridge Mathematical Series." (Cambridge: Deighton, Bell, and Co., 1892.)

THE success this work has achieved will be gathered from the fact that this is the fifteenth edition, so that any further criticism on our part would be quite unnecessary. The brief snatches of historical matter, together with the lucid and simple explanations, all tend to stir up in the student an amount of interest which in the reading of many other works on this subject lies dormant. By a careful study of the illustrations, especially those relating to pumps, presses, &c., the beginner may gather much knowledge about the principles on which they are based. In this edition the text has undergone a careful revision, several alterations and additions having been made. A uniform system of units has been maintained throughout, and the chapters on the motions of fluids and on sound, which in previous editions were inserted among those on the equilibrium of fluids, have here been separated. The examples and problems at the termination of each chapter are as numerous as ever, a new edition of their solutions being near completion. Both at the Universities and elsewhere, the work will still continue to occupy the high position which it has held among treatises of its kind. W.

The Threshold of Science. By C. R. Alder Wright, F.R.S. Second Edition, Revised and Enlarged. (London: Charles Griffin and Co., 1892.)

THE primary aim of this book is to interest young readers in various simple and amusing experiments, illustrating some of the chief physical and chemical properties of surrounding objects, and the effects upon them of light and heat. In the present edition the author has made no change which is likely to interfere with this object, but he has added various scientific appendices, and an excellent chapter on the systematic order in which class experiments should be carried out for educational purposes. These additions will be of great service to all who may wish to use the volume not merely as a "play-book," but as an instrument for the training of the mental faculties. Any one who may still have doubts regarding the value of elementary science as an organ of education, will speedily have his doubts dispelled if he takes the trouble to understand the methods recommended by Dr. Alder Wright. The majority of the experiments he has selected must not, of course, be studied merely in his exposition. It is intended that each reader shall make them himself. If that is done, they cannot fail to quicken the intelligence even of "the average boy."

Key to J. B. Lock's Elementary Dynamics. By G. H. Lock, M.A. (London: Macmillan and Co., 1892.)

THIS key will be found most useful both to beginners and teachers alike. The examples are all carefully worked out, many of the more difficult problems being treated at greater length with the view of helping those who are studying without the aid of a teacher. By an intelligent use of this book, a student should acquire a good knowledge of the method of working out problems as well as the important factor of attacking them in the right way. W.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Ice in the South Atlantic.

THE following account of ice met with in the South Atlantic at the commencement of last April, which has been supplied to the Meteorological Office by Captain Froud, of the Shipmasters' Society, may be of interest to your readers.

ROBERT H. SCOTT,
June 17. Secretary, Meteorological Office.

Ship *Cromdale*, London.

SIR,—I now send you a short account of my unusual encounter with ice in the above ship on our homeward passage from Sydney.

We left Sydney on March 1, and having run our easting down on the parallel of 49° to 50° S., rounded the Horn on March 30 without having seen ice, the average temperature of the water being 43° during the whole run across.

At midnight on April 1, lat. 56° S., long. 58° 32′ W., the temperature fell to 37°·5, this being the lowest for the voyage, but no ice was seen, although there was a suspicious glare to the southward.

At 4 a.m., April 6, lat. 46° S., long. 36° W., a large berg was reported right ahead, just giving us time to clear it. At 4.30, with the first sign of daybreak, several could be distinctly seen to the windward, the wind being north-west, and the ship steering north-east about nine knots. At daylight (5.20) the whole horizon to the windward was a complete mass of bergs of enormous size, with an unbroken wall at the back; there were also many to the leeward. I now called all hands, and after reducing speed to seven knots, sent the hands to their stations and stood on. At 7 a.m. there was a wall extending from a point on the lee bow to about four points on the quarter, and at 7.30 both walls joined ahead. I sent the chief mate aloft with a pair of glasses to find a passage out, but he reported from the topgallant yard that the ice was unbroken ahead. Finding myself embayed, and closely beset with innumerable bergs of all shapes and sizes, I decided to tack and try to get out the way I had come into the bay. The cliffs were now truly grand, rising up 300 feet on either side of us, and as square and true at the edge as if just out of a joiners' shop, with the sea breaking right over the southern cliff and whirling away in a cloud of spray. Tacked ship at 7.30, finding the utmost difficulty in keeping clear of the huge pieces strewn so thickly in the water, and having in several cases to scrape her along one to get clear of the next. We stood on in this way till 11 a.m., when to my horror the wind started to veer with every squall, till I drew quite close to the southern barrier, having the extreme point a little on my lee bow. I felt sure we must go ashore without a chance of saving ourselves. Just about 11.30 the wind shifted to the south-west with a strong squall, so we squared away to the north-west, and came past the same bergs we had seen at daybreak, the largest being about 1000 feet high, anvil-shaped, and at 2 p.m. got on the north-west side of the northern arm of the horse-shoe shaped mass. It then reached from four points on my lee bow to as far as could be seen astern, in one unbroken line. A fact worthy of note was that at least fifty of the bergs in the bay were perfectly black, which was to be accounted for by the temperature of the water being 51°, which had turned many over. I also think that had there been even a small outlet at the eastern side of this mass the water between the barriers would not have been so thickly strewn with bergs, as the prevailing westerly gales would have driven them through and separated them.

I have frequently seen ice down south, but never anything like even the smaller bergs in this group. I also had precisely the same experience with regard to the temperature of the water in our homeward passage in the ship *Derwent* three years ago, as we dipped up a bucket of water within half a mile of a huge berg and found no change in the temperature.

I trust you will warn, as far as possible, those about to sail for the Cape, as these bergs must soon reach that part.

I remain, yours truly,
(Signed) EDGAR H. ANDREW, Master.
June 12.

Land and Freshwater Shells peculiar to the British Isles.

MR. COCKERELL, in his article in NATURE of May 26 (p. 76), draws attention to a list of land and freshwater shells peculiar to the British Islands in Dr. Wallace's new edition of "Island Life." This work is of such very great importance to every one engaged in the study of the geographical distribution of animals, that it is regrettable the author should have repeated an error made in the first edition. *Geomalacus maculosus*, as is mentioned in Mr. Cockerell's article, is not peculiar to the British Islands. A specimen was discovered in Northern Spain as far back as 1868 by Mr. von Heyden, and recorded in the *Nachrichtsblatt d. deutschen Malakozool. Gesellschaft* by Heynemann in 1869. The allied species, supposed to have been found in France, has been proved to be an Arion; but several species of the interesting genus Geomalacus have been recently described by Simroth from Portugal.

Mr. Cockerell also states that several varieties in the list of peculiar British forms may have to be eventually struck out; and this is certainly the case, as the variety *albolateralis* of *Arion ater*, mentioned as "very distinct," was found near Bremen, in Germany, and is described in Simroth's "Naturgeschichte der deutschen Nacktschnecken" (*Zeitschr. f. wiss. Zoologie*, vol. 42, 1885). R. F. SCHARFF.

22 Leeson Park, Dublin, June 13.

THE IMPERIAL INSTITUTE.

THE Imperial Institute is no longer a castle in the air, an abstraction the meaning of which is to be guessed at through a veil of mist, but a solid and handsome structure, affording a pleasant contrast to those in its immediate vicinity.

The objects and purposes which this institution should fulfil have been fully ventilated and discussed in these columns ever since the idea of such a national memorial, commemorative of the fiftieth year of the reign of Her Majesty, was suggested. This being so, it will be interesting to many of our readers if we make one or two comparisons of the scheme as it exists at present with the past suggestions. In an article on "Science and the Jubilee" in 1887 (NATURE, vol. xxxv. p. 217), we wrote:—

". . . . There is room for an Imperial Institute which might without difficulty be made one of the glories of the land, and which would do more for the federation of England and her colonies than almost any other machinery that it is possible to imagine. But it must be almost exclusively a scientific institution. Its watchwords should be 'Knowledge and Welcome.' England, through such an institution, should help her colonies in the arts of peace, as she does at present exclusively in the arts of war. In an Imperial Institute we can imagine the topography, the geology, the botany, and the various applications of science, and the industries of Greater Britain going hand in hand."

Again, referring to the proposed inclusion of an Emigration Office in the scheme, it was remarked:—

"With this we cordially agree. But the return current must be provided for. Those who have lived in England's colonies and dependencies know best the intense home feeling, and in many cases the stern necessity there is of close contact with the mother country. Let the Imperial Institute be England's official home of her returning children—the hall in which she officially welcomes them back. Let them here find all they need, and let information and welcome be afforded with no stinted hand."

An inspection of the parts already ready for occupation in the new building took place on Saturday last, and we confess frankly that the idea of "Welcome" referred to in the preceding paragraph has been fully carried out. The building is admirable architecturally, and in the various halls set apart for the purpose the children of the Greater Britain beyond the seas will find no unworthy home when they visit the mother country. Their intercourse will not be confined to meeting each other; the proposal to create home Fellows of the Institute will, no doubt, be taken advantage of by all interested in all the larger questions on which the progress of the Empire must depend. By this means an Imperial Club of a very real kind has been created.

So far, then, as one of the watchwords, "Welcome," is concerned, there is cause for sincere congratulation. It is too soon to discuss the many proposals regarding the other watchword, "Knowledge," with the future activity of the Institute in the second direction. The lines of activity already actually taken up and provided for in the building as now arranged may be gathered from a glance through the pages of the pamphlet and papers distributed on Saturday.

The contents of the galleries will constitute "a living representation of the resources of the Empire and of the condition of its industries and commerce." The permanent collections will illustrate "the natural and industrial products of the United Kingdom, of the several Colonies, and of India," while, from time to time, occasional exhibitions will be held which will, "it is hoped, stimulate and enlist the sympathies of Colonial, Indian, and British producers, and promote active co-operation with the industrial section of the Empire."

The collections will be arranged and described in such a manner as to afford full "scientific, practical, and commercial information relating to the sources, nature, facilities of supply, and applications of well-known natural products, and of those whose industrial or commercial value still needs development." The libraries, offices of reference, reading-rooms, &c., in conjunction with the above exhibits, should form therefore a mine of wealth. We note also an arrangement by which samples of products will be given to anyone who may be desirous of obtaining specific information respecting any particular product included in the collection.

Ample opportunities are to be offered for conference on matters of common interest, and for the interchange of information relative to both Great and Greater Britain.

Such, then, are some of the points included in the preliminary arrangement of the building. No one, we suppose, considers them as final. Natural selection will come in, and it rests with the representatives of the scientific bodies among the governing body to determine which parts of "Knowledge" of the higher kind shall be fostered. This is a problem for the future. We need not stop to consider it now.

One word about the building itself and the allocation of space.

Passing through the principal entrance, which is constructed altogether of Portland stone, the large reception hall is reached, which, when finished, will constitute one of the finest we have, various marbles and Indian teak panelling being profusely used.

The principal floor contains in its western corridor the British-American and British-Australasian conference rooms, the council chamber, and the secretarial and clerical offices; and in the eastern corridor the British-Indian and British-African conference rooms, the writing, reading, and news rooms, and the temporary library. The principal stairway, leading to the second floor, will, when finished, be a handsome piece of work; the steps will be of Hopton Wood stone, with marble balusters and rails, while the walls will be lined with specimens of British and Colonial marbles, and the ceiling profusely decorated with arabesque plaster.

On the first floor the Fellows' dining and reading rooms are situated. The rooms in the east corridor, occupied at present by a very interesting exhibition of Indian art metal work, will subsequently be used for the commercial department and commercial conferences. In the west corridor various rooms will be put at the disposal of various Societies "whose objects are kindred to those of the Imperial Institute."

On the second floor will be situated the public dining and refreshment room. Here also the rooms in the west corridor and on the south side will be used as sample examination rooms: there will also be a map room and a Fellows' smoking room. The east corridor will, we are somewhat ambiguously informed, be occupied probably by "certain Societies who are seeking the splendid accommodation which the Institute affords for carrying on their work." When these Societies are named, the policy of the governing body in this direction will become more obvious.

TIME STANDARDS OF EUROPE.

THE era of world time is yet far off, and it is certain that the desirable scheme for a uniform horary standard put forward by the Astronomer-Royal (NATURE, vol. xxxiii. p. 521) will not be realized this century. But though this be so, signs of better times in the reckoning of the hours of the day have recently appeared, and the practical outcome of the Prime Meridian Conference at Washington (NATURE, vol. xxxiii. p. 259) is already of importance. Time is a problem to us all—a problem which has baffled the philosopher, driven the astronomer to devices which closely resemble subterfuges, and harassed the watchmaker beyond all other craftsmen. Much light on the difficult but all-important question is focussed in Mr. Lupton's article in NATURE, vol. xxxix. p. 374; but education will do more than it has yet done when the average man succeeds in understanding what he cannot but believe, that forenoon events in Australia are printed in British newspaper offices before daylight on the day they occur, while morning doings in Hawaii cannot fly fast enough by cable to catch the latest edition of the evening papers. In strict justice the time of no two meridians should be the same; and as a matter of fact, in pre-railway days every town, and every garden large enough to boast a sun-dial, set itself by its own local time. Railways have made the uniformity of time within narrow belts of longitude a necessity, and so largely does the railway affect modern civilized life that railway time soon comes to regulate all affairs. The vexation of frequent changes of time standards is familiar to all who have travelled on the Continent, and for many practical purposes the change which has been quietly progressing for the last few years is a benefit of great value. This change was brought home to the dwellers in Belgium and the Netherlands on May 1, 1892, by the retardation of all the railway clocks by from ten to twenty minutes from local to Greenwich time, an alteration of the time-gauge of two countries far more significant than the conversion to standard gauge of the railways of England.

At the Poles, where all meridians converge, there can be no natural standard time, for it is every hour of the day at once; but the regulation of time at these singular points has not yet become a burning question. Were the system of time-reckoning recommended by the Prime Meridian Conference carried out in its entirety, the minutes indicated on all well-regulated clock-dials throughout the world would be the same at a given instant, but the hours would differ at each 15° of longitude by steps of one, twenty-four standards encircling the globe. Thus, for example, at 25 minutes past noon of the prime (or rather the zero) meridian, clocks 90° E. would show 25 minutes past 6 p.m. (18h. 25m.); those 90° W., 25 minutes past 6 a.m. (6h. 25m.); and those at 180°, 25 minutes past midnight. The zero meridian adopted by the Prime Meridian Conference is that of Greenwich; and definite time standards based on hourly intervals from this starting-line have been used since 1883 on the railways of North America. That continent is divided into strips 15° in width, in each of which a separate time standard prevails, from the Gulf of Mexico to Hudson Bay. Atlantic time in the eastern provinces of Canada, and in Newfoundland, shows 8 a.m. at Greenwich noon; Eastern time in the Atlantic States of the Union marks 7 a.m. at the same moment; while Central, Mountain, and Pacific time indicate respectively 6, 5, and 4 a.m. The meridians which set the clocks across America are those of 60°, 75°, 90°, 105°, and 120° W.

The conditions in Europe are more complicated than in America. Each small closely-peopled country, with its national Observatory, naturally tends to adopt throughout its particular national time, although even this is still a desideratum in some. In the difficult subdivisions of Imperial Germany especially, the number of independent and unrelated standards was a grievous obstacle to the interpretation of through railway time-tables.

The British Islands, lying at the extreme west of Europe, should logically keep time of the zero meridian, which intersects Greenwich Observatory; while the Russian Empire (in Europe at least) was by its system of central government and State control of railways equally committed to the time of St. Petersburg. But Pulkova Observatory lies two hours east of Greenwich plus one minute and a quarter, and the alteration required is so small that it may be said already to constitute East European time, two hours in advance of Greenwich, or the standard time of West Europe. The meridian of 15° E., running through Norway, Sweden, Germany, Austria, and Italy, corresponds to Central European time, one hour in advance of that of Greenwich, and if national prejudices and local inertia were overcome, the time of Europe would be placed on a very simple footing by its adoption. The railways of Austria-Hungary have used Central European time on this system since October 1, 1891. More than fifty towns in the monarchy have since then regulated their clocks to correspond, Vienna being the only conspicuous exception, where local time is used for local purposes. Servian time-tables have been assimilated to those of Central Europe, and Bulgarian to Eastern Europe; while Turkey, pulled two ways, yields on both sides, following Central European time on the Salonika railway and Eastern European time on the Constantinople line.

In Sweden railway time has been that of Central Europe (15° E.) since 1879, and in South Germany the change to the same standard took place on April 1, 1892, a fact of much greater importance, because a feat very difficult to accomplish. The four standards of Bavaria, Würtemberg, Baden, and Alsace-Lorraine were previously in use concurrently, and the change involved retarding the nominal hours of all trains from 14 minutes in the case of Bavaria to 34 minutes in that of the Reichsland. Luxemburg came into harmony with the rest of Central Europe at the same date, with the loss of 36 minutes.

By a decision of the Federal Council in May last, mean solar time of the 15th meridian will become standard time for the whole German Empire on April 1, 1893, when it exclusively will be employed for railway, telegraph, and all State purposes. Already several places in North Germany have adopted the new time, and it can only be a matter of a few years for the simpler uniform system to acquire a footing for all the purposes of private life.

The number of European time standards is stated by Dr. Busschere [1] to have been 24 on January 1, 1891, and by the end of 1892 it will only be 13. Of these, three are meridional standards, while ten are the times of capitals, viz: Paris, Madrid, Lisbon, Rome, Berne, Bucharest, Athens, Copenhagen, Berlin, and St. Petersburg, but the last, as already mentioned, practically belongs to the former category. It now remains only for France, Spain, and Portugal to adopt Western European time, for Denmark, Switzerland, and Italy to accept Central time, and for Greece and Rumania to join the other Balkan States in using Central or Eastern time, and the change will be complete.

Strangely enough, although foreign writers tacitly assume that the British Islands are at one in their time standard, there exists in the United Kingdom a diversity as illogical as that which formerly reigned in the States of Southern Germany. While Great Britain and the small island groups associated with it keep the time of the initial meridian, now extended to Belgium and Holland on the east, Ireland is regulated by Dublin time. Thus it happens that when the post-office clock in Stornoway (6° 15′ W.) shows noon, that in Donaghadee (5° 30′ W.) only marks 11h. 35m.

As long ago as 1888, Japan adopted for its standard time that of the ninth hour interval from Greenwich (135° E.), so that the clocks which regulate the movements of the Japanese are set nine hours in advance of ours.

India, Australia, and Cape Colony remain independent in their time relations, although so simple a readjustment as is required might form a graceful concession to the spirit of federation without sacrifice of local dignity or utility.

There is no authentic publication known to us which sets forth the time standards actually employed in the chief towns of the world, but fallacious information on the subject is to be found in many atlases and clock-face diagrams. Even so eminently practical a work as "Bradshaw's Railway Guide" contains month after month a map graduated on the margin to show the difference of time between Greenwich and the rest of

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[1] Bulletin of the Royal Belgian Geographical Society, 1892, No. 2, p. 196. From this paper many of the statements given above have been derived.

England, leaving it to be implied that the local time thus shown is that actually employed, and Kelly's famous directories are disfigured with similar tables.

It is much to be regretted that the system of numbering the hours of the day from 0 to 24 has failed to hold the popular fancy. Despite the big clock-face on Greenwich Observatory, people still know their hours by the old ambiguous titles. Usually there is no room for misunderstanding, but mistakes are sometimes possible. A foreign potentate visiting this country recently was much *fêted* during his short stay, breakfasts, luncheons, and dinners being given in his honour, when a certain judge issued a card of invitation to a "Reception at 10 o'clock," which some of the guests interpreted as a.m., and others as p.m. Missing a foreign Prince through such ambiguity is a trifle compared with missing a train or miscalculating the length of a journey, and yet we know of no English time-table (we have heard of American) in which the simple plan of naming the afternoon hours from 12 to 23 is adopted. The method is occasionally used in the record of scientific observations, and always with advantage.

The present time-standards on the railways of Europe may be summarized as follows:—

(1) *Time of the initial meridian* (Western Europe) 0° (12.0):—Great Britain, Belgium, the Netherlands.

(2) *Time of the first hour interval* (Central Europe), 15° E. (13.0): Sweden, Luxemburg, Germany (Prussia excepted temporarily), Austria-Hungary, Servia, Bulgaria, Western Turkey.

(3) *Time of the second hour interval* (Eastern Europe), 30° E. (14.0): Eastern Turkey, Russia (practically).

Countries conforming to national standards or to no system, with the hour adopted in their capitals at Greenwich noon: Ireland (11.35), France (12.9), Spain (11.46), Portugal (11.23), Switzerland (12.30), Italy (12.50), Rumania (13.44), Greece (13.35).

HUGH ROBERT MILL.

NOTES.

MR. H. T. STAINTON, F.R.S., the well-known entomologist, has been appointed one of the Curators of the Hope Professorship at Oxford, to fill the vacancy caused by the death of Prof. Moseley.

SIGNOR GIUSEPPE FIORELLI is retiring from the general direction of the antiquities of Italy, and his friends and admirers have resolved to mark the occasion by giving expression to their high appreciation of his work as an archæologist. A committee has been appointed by the Accademia dei Lincei to make the necessary preparations. It is proposed that a medal shall be struck in his honour, and that any sum which may remain after this has been done shall be set apart for the encouragement of archæological studies in accordance with Signor Fiorelli's suggestions.

THE second International Congress of Physiology is to be held at Liége on August 28 to 31.

ON Tuesday a conference was held at Lord Brassey's house for the consideration of the best means of establishing a laboratory of marine biology in Jamaica in commemoration of the fourth centenary of the discovery of America. Lord Rosse moved the first resolution, "That an observatory of marine biology in tropical seas is necessary for the development of science." Prof. Ray Lankester seconded the resolution, and in doing so said that nothing could do more to advance our knowledge of biology at the present moment than the work of such a laboratory as that which it was proposed to establish. They wanted a place where the naturalist could work, and above all they wanted an organization, with a permanent official in charge who would gradually accumulate knowledge of the animals and plants which were to be found in the surrounding waters. They wanted in such a laboratory the means of dredging. He hoped they would have a steam vessel, and that the vessel would be large, and the actual building of the laboratory small. He trusted that there would be an adequate private subscription to enable them to build the laboratory, but the carrying on of the work would require an annual income, which he hoped the home Government and the island Government would be prepared to find. The resolution was carried unanimously. Mr. Villiers-Stuart moved, and Mr. Wellesley Bourke (M.L.C., Jamaica) seconded, "That no tropical sea promises so rich a harvest of biological specimens as the great gulf of the West Indies; that Jamaica is the most central and most suitable station for such an observatory, and that its establishment would be a suitable memorial of the fourth centenary of the discovery of the Western Hemisphere." This also was unanimously agreed to.

THE Crystal Palace on Saturday last was specially visited by Lord Kelvin to view the National Electrical Exhibition at present being held in its buildings. This Exhibition, as everyone who has seen it must be aware, is a thoroughly representative one, and besides illustrating the present condition of the application of electricity for practical purposes, carries one back especially in the Post Office exhibit, to the time of its infancy: the historical collection is of considerable importance, and has been well selected. Instruments are there shown, which have five needles on their dials, the presence of which was once necessary to carry on a conversation, the number of words spoken per minute amounting only to single figures. Very interesting old specimens of cables are also shown, together with the part of a telegraph post connected with the pathetic case of a poor woodpecker which, in the endeavour to find the insect that was producing (so he thought) the humming noise in the post, had pecked a large hole in it. In the demonstration room of Messrs. Siemens Brothers, some truly wonderful sights were displayed. The flame produced by exciting an induction-coil by means of an alternating current was produced on a very large scale, and as it issued from the secondary poles, was made to pass through pieces of wood, lumps of salt and slate, the most striking case being its passage through a large piece of plate glass, for which a very strong current was required. Among the many other exhibits, we may mention the demonstrations in cooking by electricity. The bottom of the kettle or saucepan is coated with a specially prepared enamel, into which a fine wire resistance is embedded; by this means, as the wire becomes heated, the temperature of the kettle, and therefore of the water in it, is raised. We may note that the Exhibition closes on Saturday, July 2, so that those who have not already visited it should do so without delay.

A REUTER'S telegram from Vizagapatam, Madras, announces the death of Mr. Narasinga Row, the well-known native astronomer. He died on Saturday last.

THE death of Hermann Burmeister, the well-known German zoologist, at Buenos Aires, is announced. He died on May 1 in his eighty-sixth year. In his early days he was a Professor of Zoology at Halle. During the revolutionary period of 1848 and the following years he associated himself prominently with the Liberals, the result being that in 1850 he had to quit Germany. He travelled for some time in Brazil, and then returned to his native country. He went back to South America in 1856, and not only visited most parts of the Argentine Republic, but crossed the Andes by a way which had never before been taken by a European. After another brief visit to Germany, he finally settled in Buenos Aires in 1861, where he formed the well-known National Museum of Natural Science. Only an accident made it necessary for him to resign his position as Director, and the community, by which his services were highly appreciated, took care that he was properly pensioned. He was buried at the cost of the State, and the President was present at the funeral.

DURING the latter part of last week an area of high pressure lay over the Bay of Biscay and the west of France, and an area of low pressure over Scandinavia and the North Sea, causing moderate north-westerly and westerly winds over these islands. The temperature had continued low, the maxima only exceeding 60° at a few places, chiefly in the southern parts of the kingdom, while the nights were very cold for the time of the year, with ground frosts over the inland parts of England. Thunderstorms occurred in many parts, with heavy showers of rain, and hail in the south-east of England. At the beginning of the present week the low barometer extended gradually over the kingdom, and shallow depressions were travelling from west to east. With this distribution of barometric pressure, the winds were from north and east over Scotland, and chiefly from between north-west and south-west over England and the Channel; subsequently the barometer readings became more uniform, and the winds light and variable. The weather continued very unsettled, although there was some increase of temperature. The report issued by the Meteorological Council for the week ended the 18th instant shows that the mean temperature was below the average for the week in all districts, the deficit ranging from 3° in the Channel Islands to 8° in the Midland and Eastern Counties of England. Rainfall was only slightly above the mean in the east of Scotland.

THE Washington Weather Bureau has just distributed two important meteorological papers prepared by General A. W. Greely, Chief Signal Officer. (1) A series of thirty-seven charts showing the absolute maximum and minimum temperatures in the United States for decades, and for all years combined, compiled from observations taken from 1872 to June 1891. The values, together with the date of occurrence, are printed over the names of the stations on ordinary maps, and show very clearly for each locality the limits within which the temperature may be expected to range. (2) Diurnal fluctuations of atmospheric pressure at twenty-nine selected stations in the United States. The tables give the corrections necessary to reduce the mean pressure at any hour of the day to the true daily mean. The values have been obtained by freehand curves from all the available observations from January 1877 to June 1888. It is found that the fluctuations of the secondary maxima and minima diminish from south to north, especially during the summer months. The daily variation in pressure decreases with increasing latitude, especially in the winter months; in summer the same conditions exist, except that the daily range increases inland from the coast. The principal maximum occurs over the whole of the United States in January, about 9h. 45m. a.m. (local time), except along the New England coast, where it is earlier; as the year advances the hour gradually shifts towards the earlier morning until June, after which a reversal gradually occurs. The delay in the hour of the principal minimum is more marked: it gradually becomes later with increasing longitude; the most decided lagging in the summer minimum is in the neighbourhood of the Great Lakes.

PROF. R. KOBERT gives, in the *Chemiker Zeitung* (1892; 16, No. 39), an account of Williams's frog heart apparatus. The apparatus, as modified by Maki, Perles, and Kobert, consists of an arrangement of glass vessels and india-rubber tubes, whereby a heart taken from a newly-killed frog can be made to maintain an artificial circulation of blood, fresh or injected with any poison the effect of which it is sought to determine. The tubes and vessels are mounted on a stand about 1 foot high. The heart is suspended by a cannula leading into a three-way tube communicating with two vertical glass cylinders fitted with glass valves. Through one of these the heart is supplied with blood, either fresh from a rabbit, calf, or dog, and diluted with 0·75 per cent. salt solution, or poisoned. The other vertical cylinder leads back from the heart to the vessel from which the fresh blood is supplied. To start the action, fresh blood is allowed to enter the heart, which is thereby excited to a contraction, and pumps it back into the reservoir. The height through which it is raised, and the quantity that is raised in a given time, gives the work done, and the number of pulsations, and the volume raised in a given time determines the pulse-volume. The force exerted is measured by a small mercurial manometer, which may be rendered self-registering. To study the action of poisons on the power and vitality of the heart it is only necessary to admit the poisoned blood from the second reservoir. When the pulsation has ceased or diminished, fresh blood may be re-admitted, which in many cases restores the pulsation. We have received a letter on this subject from Count F. Berg, of Livonia, who says Prof. Kobert is of opinion that the apparatus, if it were more generally known, would be of great service for the advancement of science, and would render unnecessary many an otherwise indispensable experiment in vivisection.

WE have received a new planisphere, which is being sold by the *Register* Publishing Company, Ann Arbor, Mich. The rotary disk, on which the constellations are clearly marked, is made of good stiff cardboard, and the days of the year round the edge are neatly printed in white figures on a blue background. The planisphere is arranged for latitudes 38° to 48°, and shows on its disk all the principal stars in each constellation, with their lettering, and in some cases their names; thus, α Boötis = Arcturus, α Lyræ = Vega, &c. By simply turning the disk round until the day of the month comes opposite the time of day, the stars above the horizon at that time can at once be seen. On the back is a table for finding the times of visibility and positions of the planets, while there is also a key to enable one to determine the name of a planet which cannot be recognized. When once used, the handiness of such a planisphere as this will soon make itself apparent; and not only will it be adopted by possessors of telescopes, but it should be in the hands of all those who wish to be able to find and correctly name the various constellations.

INQUIRIES have recently been made by the British Consuls in Japan as to the various native industries that have sprung up for the production of articles which have hitherto been imported into that country from abroad. A summary of the information thus obtained has been prepared by Mr. Gubbins, Secretary of Legation at Tokio, and has been printed in the Foreign Office Miscellaneous Series. Mr. Gubbins says that in the case of some of the industries introduced into Japan, the country is now self-supporting, foreign competition being no longer possible; in others so much has been accomplished as to render it certain that the time is not far off when importation will altogether cease. The future of other industries again—such as that of cotton-spinning—though not so assured, is still hopeful; while even in those branches in which the least results have been obtained she possesses a constant advantage in the great cheapness of labour. Mr. Gubbins thinks that this progress has not been made at the sacrifice of any of the various artistic industries which are more peculiarly her own. While admitting that there is truth in the criticism that would disparage her progress for the reason that it is imitative and not constructive, he holds that the fact that Japan, an Oriental country, has been able to dissociate herself from her sister countries of the East and to profit by Western inventions to the extent that is in evidence augurs well for the years to come.

IN the new number of the *Records of the Australian Museum* (vol. ii., No. 1), Prof. Alfred Newton, F.R.S., has a note which may be of interest to ornithologists in Australia. Having lately occasion to investigate the range of the sanderling (*Calidris arenaria*), he came across a memorandum made in the year

1860 of his having then seen, in the Derby Museum at Liverpool, two specimens of the larger race of this species, one in winter dress and the other in incipient spring plumage, both being marked as females, and as having been obtained at Sandy Cove in New South Wales, April 20, 1844, by the late John Macgillivray. This wandering species does not seem to have been hitherto recorded from Australia. Prof. Newton finds little verification of Temminck's assertion in 1840 ("Man. d'Ornithologie," iv. p. 349), often repeated in one form or another, that the sanderling occurs in the Sunda Islands and New Guinea; or even of a statement made by a recent writer in general terms, that it is a winter visitor to the islands of the Malay Archipelago ("Geographical Distribution of the Charadriidæ, &c.," p. 432). Java seems to be the only one of these islands in which its presence has been determined, and though it was included with a mark of doubt in the lists of the birds of Borneo by Prof. W. Blasius (1882) and Dr. Vorderman 1886) respectively, it has been omitted, and apparently with reason, from that of Mr. Everitt (1889). It is well known to pass along the whole of the west coast of America, and it has been obtained in the Galapagos and the Sandwich Islands, but Prof. Newton knows of no instance of its having been observed in any Polynesian group or within the tropics to the eastward of Java.

IN the same number of the *Records of the Australian Museum* is a valuable paper (with plate), by Mr. Charles Chilton, on a Tubicolous Amphipod from Port Jackson. Among some Australian Crustacea sent to Mr. Chilton as exchanges by the trustees of the Australian Museum was a tube-dwelling Amphipod collected in Port Jackson. There was a plentiful supply both of specimens and of the tubes formed by them, and after a full examination and comparison of them with Mr. Stebbing's description and figures, Mr. Chilton has no doubt that they belong to *Cerapus flindersi*, Stebbing, a species described from a single female specimen taken in Flinder's Passage during the voyage of the *Challenger*. Mr. Stebbing says nothing of the tube in his description, and Mr. Chilton presumes, therefore, that he has not seen it. Mr. Chilton is able to supplement Mr. Stebbing's description in this respect, and to describe the male of the species, and to give the points in which it differs from the female, and also some interesting facts on the changes in form that occur during the growth of the male.

SOME time ago the *Ceylon Observer* gave an account of the killing of a wild boar by a cheetah near Galle. In its issue of May 25 it prints a letter from Mr. Clive Meares, who says that the fortune of war has now gone the other way, a cheetah having been killed by a wild boar. The coolies of Ginniedominie estate, Udagama, on going to work on the morning of May 23, discovered in a tea-field near the jungle signs of a severe struggle having taken place between a cheetah and a wild boar—judging by the marks. On further search the dead body of a cheetah was discovered in the tea, death having evidently been caused by the severe handling it had received from the boar. The brain being very much congested with blood and several teeth marks deeply buried in the neck, there could be no doubt as to the cause of death. On the animal being skinned the wounds were found to be very deep. She weighed 42 pounds, and she was 71 inches long from nose to tip of tail, and 24 inches in height at the shoulders.

MR. A. REA, the Superintendent of the Archæological Survey, Madras, has reported an important discovery he has made of another casket, some relics, and inscriptions in the Buddhist stupa at Bhatuprolu in the Kistna District. In Sewell's *List of Antiquities*, vol. i. p. 7, mention is made of a casket found in the dome of the stupa some years ago. It struck Mr. Rea that as the chief deposit was usually placed near the centre of the foundations, it was probable that another casket might be found. Copies of his report, with inscriptions, have been ordered to be sent to Dr. Hultzsch, the Government Epigraphist; to archæological experts in India, and to various learned Societies.

MINING seems likely to be splendidly represented at the Chicago Exhibition. It is announced that "all of the precious minerals, all of the economic minerals, all of the precious stones, all of the coals, all of the building stones and marbles, all of the clays and sands, all of the salts and pigments, as well as the machinery, implements, and appliances employed in their conversion to the uses of man, will be fully represented." Especial attention will be devoted to the iron industry. The Exhibition will provide ample data as to the location and extent of the greater iron deposits, the analyses of the ores, with all the machinery and devices employed in mining, hoisting, conveying, storing, &c.

PROF. DANIEL G. BRINTON contributes to the new number of the Proceedings of the American Philosophical Society, vol. xxx., No. 137, valuable papers on the Chintantec language of Mexico, the Mazatec language of Mexico and its affinities, and South American native languages. Of the latter languages he says that they are the least known of any in the world.

A VOCABULARY of the Eskimo language has been compiled by M. Ryberg, a Danish official in Greenland. It represents work carried on during fifteen years.

THE publication of the quarterly journal for cryptogamic science, *Grevillea*, will still be continued under the proprietorship of Mr. E. A. L. Batters, and the editorship of Mr. George Massee.

MR. E. D. MARQUAND has published a list of the flowering plants and vascular cryptogams of Guernsey. It includes the remarkable number of 636 flowering plants, 18 ferns, and 9 fern allies. Of these about 130 are not recorded for Guernsey in Prof. Babington's "Primitiæ Floræ Sarniceæ."

THE latest researches of the Finnish expedition to the Kola Peninsula will modify the position of the line which now represents on our maps the northern limits of tree-vegetation in that part of Northern Europe. The northern limit of coniferous forests follows a sinuous line which crosses the peninsula from the north-west to the south-east. But it now appears that birch penetrates much farther north than the coniferous trees, and that birch forests or groves may be considered as constituting a separate outer zone which fringes the former. The northern limits of birch groves are represented by a very broken line, as they penetrate most of the valleys, almost down to the sea-shore; so that the tundras not only occupy but a narrow space along the sea-coast, but they are also broken by the extensions of birch forests down the valleys. As to the tundras which have been shown of late in the interior of the peninsula, and have been marked on Drude's map in Berghaus's atlas, the Finnish explorers remark that the treeless spaces on the Ponoi are not tundras but extensive marshes, the vegetation of which belongs to the forest region. The Arctic or tundra vegetation is thus limited to a narrow and irregular zone along the coast, and to a few elevated points in the interior of the peninsula, like the Khibin tundras, or the Luyavrurt (1120 metres high). The conifer forests, whose northern limit offers much fewer sinuosities than the northern limit of birch-growths, consist of fir and Scotch fir; sometimes the former and sometimes the latter extending up to the northern border of the coniferous zone.

THE British Consul in Hainan, in his last report, says that during the past year he has made two journeys in that island, one to certain prominent hills near Hoihow, known as the "Hummocks," which lie fifteen miles to the west, on the road to Ch'eng-mai, the other a gunboat cruise to Hansui Bay. The people at both these places, and presumably all along the north-west coast, though believing themselves Chinese, speak a language which is not only not Chinese, but has a large percentage of the words exactly similar to Siamese, Shan, Laos, or Muong. The type of the people, too, is decidedly Shan, without the typical Chinese almond eye. At one time (1000 years ago) the Ai-lau or Nan-chau Empire of the Thai race extended from Yun-nan to the sea, and the modern Muongs of Tonquin, like the Shans of the Kwangsi province, the ancestors of both of which tribes belonged to that empire, probably sent colonies over to Hainan; or the Chinese generals may have sent prisoners of war over. It is certain that some at least of the unlettered, but by no means uncivilized, tribes in the central parts of Hainan speak a type of language which is totally different from that spoken by the Shan-speaking tribes of the north-west coast. Yet the Chinese indiscriminately call all the non-Chinese Hainan dialects the Li language. The subject, Mr. Parker says, is one of great interest, well worth the attention of travellers. It was his intention to pursue the inquiry when making a commercial tour of inspection round the island, but his transfer to another post compels him to abandon his scheme.

THE additions to the Zoological Society's Gardens during the past week include a Brown Capuchin (*Cebus fatuellus*) from Guiana, presented by Mr. Edward Solomon; two Black Swans (*Cygnus atratus*) from Australia, presented by Lady William Osborne Elphinstone; a Greater Spotted Woodpecker (*Dendrocopus major*), two Common Cormorants (*Phalacrocorax carbo*), British, presented by Sir H. B. Lumsden, K.C.S.I.; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. F. R. Brown; two Common Rheas (*Rhea americana*) from the Argentine Republic, deposited; an Erxleben's Monkey (*Cercopithecus erxlebeni* ♂) from West Africa, a Victoria Crowned Pigeon (*Goura victoriæ* ♀) from the Island of Jobie, two Wonga-Wonga Pigeons (*Leucosarcia picata*) from New South Wales, a Rosy-billed Duck (*Metopiana peposaca* ♀) from South America, twenty Common Teal (*Querquedula crecca*), European, purchased; a Thar (*Capra jemlaica*), two Burrhel Wild Sheep (*Ovis burrhel* ♂ ♀), an Axis Deer (*Cervus axis* ♂), four Temminck's Tragopans (*Ceriornis temmincki*), a Himalayan Monaul (*Lophophorus impeyanus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

COLOURS ON THE SURFACE OF MARS.—During the last opposition of Mars a series of observations was made by Prof. Pickering with the object of determining the general colour of this planet's disk, and that of the various markings distributed over its surface. In a preliminary account of this work which he has contributed to the June number of *Astronomy and Astro-Physics*, we are made acquainted with some of the observed facts, which will be read with keen interest, as we are nearing a time when like observations can be repeated. The instruments used were the 12-inch and 15-inch at Cambridge, and the 13-inch at Arequipa, Peru. With the two former sixty paintings were made, together with sixty-six uncoloured drawings, and with the latter some of the more recent observations were undertaken. The general light from the planet, although usually termed ruddy, was found to lie about midway between that of a candle and electric light of equal brilliancy, being somewhat bluer than the former and redder than the latter.

Great difficulty seems to have been found in matching Mars's colour in the day and night time, the presence or absence of the bluish white light reflected from the atmosphere bringing about a great difference in the colour of the pigments used. The colour finally settled upon may be represented by equal parts of dragon's blood and sienna. The ruddiness, as the limb was approached, gave way to a distinct yellow tint, due perhaps to atmospheric absorption, an effect, as Prof. Pickering remarks, which is quite at variance with the action of our own atmosphere. In addition to these colours grays and greens have been noticed, indeed at times the greens have been more intense than the red. The grey objects were found, when the seeing was very good, to have a slightly yellowish tinge about them, but when viewed by daylight a browner tint more accurately represented their colour.

Numerous observations were made also with the intention of determining the colour of those parts more darkly tinted, and the colour of the canals; but Prof. Pickering only mentions that there were indications of slight colour alterations, reserving his opinion on these points in order not to bias those of other observers, who will be able in the coming opposition to examine this planet's surface from this point of view.

During the months of July and August the planet, excepting for its low altitude, will be most favourably situated for observation, the opposition occurring on August 4, when its distance from the earth will be about 35,000,000 miles.

OBSERVATIONS OF THE MOON.—The *Monthly Notices* (vol. lii., No. 7) contains, besides the observations of the right ascensions and north polar distances of the moon made during the year 1891 at the Radcliffe Observatory, Oxford, a comparison of these results, with the tabular places taken from Hansen's lunar tables. The two suppositions on which these results are compared are, as Mr. Stone says: (1) that the mean times found in the usual way from the sidereal times at mean noon given in the *Nautical Almanac*, were not altered in scale, or affected with any different systematic errors of determination, by the adoption in 1864 of a different ratio of the Julian year of 365¼ "mean solar days" to the mean tropical year; (2) that the "mean times" which accurately correspond to a given "sidereal time of a meridian" were necessarily changed in 1864 by the use of a different ratio of the "Julian year," and therefore of the "mean solar day" to the mean tropical year, to fix the tabular right ascensions of the clock stars at the meridian transits. It is from these tabular right ascensions of the clock stars that the observed right ascensions are deduced by the aid of clocks; and the right ascensions thus found are finally rendered definite by the direct reference to the positions of the sun deduced from the north polar distances and obliquities of the ecliptic.

During the period included in the years 1847 to 1863 the mean annual error in longitude of Hansen's tables amounted to −1″·85, no regular law of increase being indicated. Taking the case of those observations made up to the end of last year, the mean annual error, as shown in the third table, has steadily increased from the year 1863 at an average rate of 0″·75 per annum, the error now amounting to as much as 19″·30. If the corrected argument be used for taking out the mean annual error of Hansen's tables during the same period, this value becomes −1″·49, which differs from −1″·85 (the value for the preceding period) by a quantity which in such a case is very small.

A PLANET BEYOND NEPTUNE?—For some time it has been thought that in all probability our sun is accompanied by one or two other planets which lie outside the orbit of Neptune. The idea gained a considerable footing in many minds after Prof. Forbes's paper, which he read in 1880 before the Royal Society of Edinburgh, his prediction being based on cometary aphelia positions. In order to investigate this question more fully, Mr. Isaac Roberts, having obtained the necessary approximate positions of these hypothetical bodies, undertook to make a search for them, employing the method of long exposure photography. The result of this search he communicates to the May number of the *Monthly Notices*.

The probable position indicated by Prof. Forbes lay between R.A.'s 11h. 24m. and 12h. 12m., with declinations 0° 0′ to 6° 0′ north; and over this region Mr. Roberts took two sets of eighteen plates, each plate covering more than four square degrees, the exposure being of 90 minutes' duration. A close examination of the plates showed that, in Mr. Roberts's words, "no planet of greater brightness than a star of the fifteenth magnitude exists on the sky area herein indicated."

GEOGRAPHICAL NOTES.

THE Royal Geographical Society's *soirée* took place on the 17th inst. at the South Kensington Museum, when the guests were received by the President and Council. The attendance was very great. The attractions of the evening included selections by the Coldstream Guards band, solo and part singing in the lecture theatre, and an exhibition by the dioptric lantern of maps and views, with explanation by Mr. H. J. Mackinder.

SOME interesting particulars as to the present state of the Marshall Islands are published in the *Deutsches Kolonialblatt*. The population is estimated at 15,000 aborigines, and about 100 whites. Cocoa-nuts and copra are the staple exports; pandanus, breadfruit, and arrowroot being cultivated on a small scale. The natural grass is not suitable for pasture, but with the introduction of foreign grass seed, cattle and sheep breeding may become profitable. Taking into consideration the character of the soil and the density of population, the future of the German protectorate in the Marshall Islands is acknowledged not to be very bright, although the authorities hope that it may become of enhanced importance for trade with Germany.

THE *National Geographic Magazine* has just published an account by Dr. Charles Willard Hayes of the expedition through the Yukon district in 1891, conducted by Mr. Schwatka on behalf of a syndicate of American newspapers. Entering by the Yaku inlet, the expedition made its way by canoe, as soon as the ice disappeared, up the Yaku River; thence it crossed the watershed, and continued on Lake Ahklen and the Teslin River to Lewes River, a tributary of the Yukon. A traverse survey was made all the way, and the route laid down in a serviceable manner, though of course without the precision of an actual survey. This district has been several times visited by prospectors, and parts of it mapped by previous explorers; but the expedition opened up, probably for the first time, the unknown region extending from the Yukon to the St. Elias Mountains. Across this blank, usually filled in hypothetically on maps, the expedition surveyed a line of 330 miles, from Selkirk, on the Yukon, to the junction of the Chittenah and Nizzenah rivers. The report gives a clear summary of the topography, drainage, orographic system, and geology of the region traversed.

PRINCE HENRY OF ORLEANS has returned to France after a difficult journey from the Upper Mekong, through the Shan States and Siam, where he reached the coast at Bangkok.

CAPTAIN W. G. STAIRS, whose quiet heroism in Stanley's Emin Relief Expedition was brought prominently before the world two years ago, has fallen a victim to African travel. He was born at Halifax, Nova Scotia, in 1863, and educated at Merchiston Castle School, in Edinburgh, subsequently studying at the Royal Military College, Kingston, Ontario. After his training in Canada he spent some time in New Zealand as a civil engineer; but obtaining a commission in the Royal Engineers, he came to Chatham, and completed his military training. When the Emin Relief Expedition was fitting out in 1887, he volunteered to accompany it; and from the first he impressed Mr. Stanley as a man of exceptional qualities —an opinion strengthened by the strict obedience and absolute loyalty which distinguished him throughout the trying years that followed. As the only member of the advance party (Dr. Parke excepted) who had much interest in scientific matters, Captain Stairs would undoubtedly have made large additions to knowledge had it not been for the imperative exclusiveness of his work as an officer. He was selected for the best piece of geographical exploration attempted during the expedition—the ascent of Mount Ruwenzori. Last year Lieutenant Stairs was promoted to a captaincy, but the fatal attraction of Africa led to his resignation in order to accept command of the Katanga Company's expedition. This Company was formed in Belgium to administer and exploit the south-eastern corner of the Congo Free State, in what is known as Msidi's country. Stairs left Zanzibar last summer, crossed to Lake Tanganyika by the familiar trade route *viâ* Tabora, and reached Mpala on October 31, after a remarkably rapid and easy journey. Thence he traversed Msidi's country in the rainy season, where he suffered much from fever, but succeeded in reaching the Ruo on May 13, and arrived at Vicenti, near the mouth of the Zambesi, on June 3. But at Chinde, just as the expedition had overcome all the difficulties of the way, and only waited for a passage to Zanzibar, Captain Stairs died. This sad event has removed from the list of African travellers one of the bravest, most prudent and modest of young explorers.

THE MICROSCOPE'S CONTRIBUTIONS TO THE EARTH'S PHYSICAL HISTORY.[1]

MEN will have forgotten much when the second half of this nineteenth century is no longer remembered. Whatever may have been its faults, it has no rival in the past history of the world as an epoch of scientific progress. This progress has been largely due to the felicitous co-operation of the mind of the student with the skill of the craftsman in the more perfect construction of instruments of research. By them darkness has been made visible; the opaque, translucent; the unseen, conspicuous; the inert, sensitive; silence, vocal. A thousand methods of experiment, tests of the most delicate nature, have been devised, so that vague conjecture has been replaced by exact knowledge, and hypothesis by demonstration. In such an epoch it may seem a little fanciful to select any one term of years as exceptionally fruitful; but it is remarkable that in the first decade of this half-century, science was enriched by three contributions, each of which has led to consequences of far-reaching import. In 1858 Charles Darwin and Alfred Russel Wallace announced simultaneously the conclusions as to the origin of species at which they had independently arrived, and the well-known book by the former author appeared in the following year. They thus formulated the results of protracted investigations and patient experiments with the simpler appliances of earlier days. They subjected, more strictly than ever before, the facts of nature to an inductive treatment, and thus lent a new impulse to biological science. Their hypothesis gave a definite aim to the researches of students, and kindled an unquenchable flame of intellectual activity. In 1860, Bunsen and Kirchoff announced the results of applying the spectroscope to problems in chemical analysis. By means of this instrument not only have investigations attained a precision hitherto impossible, but also the student, no longer cribbed, cabined, and confined, to the limits of the earth, can question the stars in their courses, and bid nebulæ and comets reveal the secrets of their history. Lastly—though the problem be in a humbler sphere, dealing with neither the immensities of stellar physics nor the mystery of life—Henry Clifton Sorby, in 1856, described the results of microscopic investigations into the structures of minerals and rocks. Strictly speaking, indeed, the method was not wholly novel. So long since as 1827, William Nicol, of Edinburgh, had contrived to make sections of fossil wood sufficiently thin for examination under the microscope; but the device, so far as I know, had not been generally applied, or its wide possibilities apprehended.

You have heard in this place on former occasions of the triumphs of the spectroscope in extra-terrestrial space; of the revelations of the microscope in regard to the least and lowest forms of life; I have ventured to ask your attention to-day to the work of that instrument in a humbler and more limited field —the constitution and history of the earth's crust. My task is beset with difficulties. Did I address myself to experts, these would be but a small portion of my audience; if I speak to the majority, it will be hard to make intelligible a subject bristling with technicalities. Moreover, as this building is so ill-suited for the usual methods of illustration, I have decided to dispense with diagrams or lantern slides, and will try to tell, in the plainest language at my command, the conclusions as to the genesis of rocks and the earlier history of the earth to which the researches of the last few years seem to be tending.

I have excluded from my story investigations which bear upon the biology of the past, though the work of the microscope in this field has not been less fruitful or interesting, because these are more widely known. Moreover, they have not specially engaged my attention, and there is, I believe, an expectation amounting to an unwritten law, that whoever has the honour to occupy my present position should be so far egotistical as to talk of the particular plot, however small it may be, on which he has laboured in the garden of science. So I will crave the indulgence of the few experts present, and the patience of the majority of my audience, while I try to tell the story of microscopical research into the history of the earth's crust.

Twenty years ago, I believe, not half that number of geologists in the British Isles made any real use of the microscope. Now they may be counted by scores, not only in the United Kingdom, but also in every civilized land. Obviously in a science so new, in a research which is extending so rapidly, much diversity of opinion must exist on some theoretical questions. Into the details of controversies it is not my purpose to enter; but I shall content myself with indicating the conclusions to which I have been led in the time which the many inevitable duties of life permitted me to devote to this branch of geology.

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[1] The Rede Lecture for 1892, delivered before the University of Cambridge, by T. G. Bonney, Sc.D., F.R.S.

Before doing this it may be well to indicate very briefly the mode in which the microscope is applied to the examination of rocks. Commonly it is as follows: slices, cut by the lapidary's wheel from minerals or rocks, are ground down smoothly till they are about one one-thousandth part of an inch thick, and are then mounted on glass. By this means most minerals, including the great majority of the ordinary constituents of rocks, become translucent, if not transparent. They are then examined under a specially-constructed microscope, fitted with Nicol's prisms and other contrivances for optical tests. Occasionally also certain chemical tests can be applied. To what extent an object is magnified depends on the nature of the investigation. A very minute crystal can sometimes be studied, under favourable circumstances, when enlarged to at least 800 diameters; but in ordinary cases, where the chief constituents of a rock and their mutual relations are the object of research, a magnification of from 50 to 100 diameters is commonly the most advantageous. Sands, clays, and incoherent materials can be readily studied by mounting them temporarily or permanently on glass; sometimes, also, good work can be done, and time saved, by crushing up fragments of minerals and of rocks, and by treating the powder thus obtained in the same way. Investigations, which promise to throw light on the problem of the development of minerals, have been recently made by examining the insoluble residues of those rocks which are chiefly composed of carbonates. Solutions of different specific gravities have proved very useful in the determination of the mineral constituents of a rock, which are sorted out by them, as by a strainer, from a sand, mud, or a powdered mass, so that each kind can be studied separately either by microscopical or by chemical analysis.

The subject evidently, in process of time, tends to divide itself into two branches: the one concerned mainly with the characters of the individual constituents of a rock, the other with the wide problem of their mutual relations, or, in other words, with the history of the rock-mass: branches properly denoted by the words *petrography* and *petrology*, though these terms are often confused. The former is more strictly a department of mineralogy; the latter a department of geology. This it is of which I chiefly speak to-day; this it is in which the most marked advances have been recently made.

How great these have been may be more readily appreciated if I mention a few matters, concerning which, even a quarter of a century since, great uncertainty prevailed. Though it was then generally admitted that one great group of rocks, such as clays, sandstones, limestones, &c., were sediments, and that another great group, the rocks called igneous, had solidified in cooling from a fused condition; the origin of a third, and by no means unimportant group, the crystalline schists and gneisses—the metamorphic rocks, as they were commonly called—was considered very doubtful. Many geologists also believed that not a few igneous rocks had been once sediments, like those in the first group, which had been subsequently fused or "digested" by the combined action of heat, water, and pressure. Thus it was supposed that clays and felspathic sandstones could be traced through various stages till they became granite, and rocks of the most diverse chemical composition could be transmuted one into the other. The province of metamorphism was the fairy-land of science; it needed but a touch of the magic wand, and, like Bottom the weaver, a rock was at once "translated." It would be easy, were it worth while, to enumerate instance after instance of these alleged transmutations, every one of which has been proved to be groundless. No doubt, even at the time named, these assertions were questioned by some geologists, but that they could be made so confidently, that they could be inculcated by the official representatives of geology in this country, shows the hopeless confusion into which petrology had fallen.

By means of the microscope also much light has been thrown upon the history even of the better known rocks. The classification of the igneous group has been simplified, and the relations of its several members have been determined. The microscope has dispelled many an illusion, and reduced a chaos to order. In regard to the sedimentary group, it often has determined the true nature of their constituents, and has suggested the sources from which they have been derived or the agents by which they have been transported. Thus, through its tube, we have been enabled, not only to gaze at the most intimate structure and composition of rock-masses, but also to catch glimpses of the earth's physiography in ages long before the coming of mankind.

But in speaking of the services rendered by the microscope, I must not forget a needful caution. If the instrument be employed for petrological rather than petrographical purposes, it must never be divorced from work in the field. No training in the laboratory, however complete, no research in a library, however laborious, can of themselves make a petrologist. No question can be completely mastered, unless it be also studied in the field; nay, even the specimens for examination under the microscope, as a rule, should be collected by the student himself, and the characters and relationships of the rock-masses from which they are detached should be carefully noted. It was said, on no mean authority, some fifty years since, that, in the education of a geologist, travel was the first, the second, and the third requisite. Perhaps the statement, like most epigrams, was somewhat one-sided, but the truth in it has not been diminished by the increased perfection of our instrumental methods. In petrology, the chimæras of the home-keeping student of the laboratory have been, and still are, as hurtful to progress, as the dreams of the peripatetic geologist, whose chief appliances are a stout pair of legs and a hammer.

This, then, was the problem which, some thirty years since, presented itself to geologists who were interested in petrology. Here are two groups of rocks, the sedimentary and the igneous. The origin of these we may be said to know, but as to that third group, which, though not as large, is far from unimportant—what is its history? what are its relations to the other two? The records of its rocks at present are illegible. Is there any hope that success will reward the attempt to decipher them? Time and perseverance have given an answer, and though much is still uncertain, though much remains to be done, some real progress, in my opinion, has been made. As the stones sculptured of old by the hand of man are yielding up their secrets, as the hieroglyphs of Egypt and the cuneiform characters of Assyria are telling the tale of the conquerors whose bones are dust, as the tongues of the children of Heth, and of the black-headed race of Accad, are being learnt anew, so the records of the rocks, wherein no trace of life is found, are being slowly, painfully, but ever more surely deciphered, and knowledge grows from year to year.

To obtain success the problem must be attacked in the following way. As the first step, the two great groups already mentioned, the origin of which is known, must be thoroughly studied. The examples selected must be nearly or quite unaffected by any agent of change, such as heat, water, and pressure. Among the specimens representative of the sediments, the materials must range from fine to coarse—for the grains in the latter serve also as samples of the rocks from which they have been broken, and suggest their own inferences. Among the igneous rocks, types ranging from the most glassy to the most crystalline forms must be examined, in order to ascertain not only the constituent minerals, but also their associations and mutual relations. Suppose this done—suppose a fairly good idea obtained of the characteristic structures and possible variations in either class—we have then to ascertain how far and in what way each representative can be modified by natural agencies. At the outset, probably, it will be found convenient to trace the processes of mineral and even of structural change without any immediate reference to the efficient cause. It soon appears that in the case of minerals, which differ in physical properties, but not in chemical composition, the one species replaces the other; the less stable gradually altering into the more stable form. Thus calcite takes the place of aragonite, hornblende of augite; one mineral may be broken up into a group, as a colloid into crystalloids, or felspar into quartz and white mica; new species may be produced by addition or subtraction of constituents from without, or by exchange from within; the replacement of silicates by carbonates, the conversion of granite into tourmaline-rock, the formation of epidote, chlorites, and serpentine, are a few among the many instances of this kind of change. By tracing the process from one part of a rock to another, numerous facts are collected and relationships ascertained. But during these investigations questions are raised in a student's mind which begin to clamour for an answer. Why does such and such a rock change, now in this way, now in that? So it becomes necessary to correlate our observations, to frame hypotheses, and open out new lines of inquiry.

So far as we know, water, pressure, heat, are the main agents in producing change in rocks, after the latter have been once deposited or solidified. In most cases it is not easy to insulate perfectly the effect of each agent, for probably every rock, which has undergone important changes, has been to some extent affected by all of them. Still many examples can be found, in which the influence of one has predominated greatly over that of the other two. For instance, it is now agreed that the structure of a slate is the result of pressure, though this probably produced a slight rise of temperature, and the rock is not likely to have been perfectly dry. Again, when a clay has been converted into an assemblage of crystalline silicates in the vicinity of an intrusive mass of granite, this is mainly the effect of heat, though the pressure cannot have been inconsiderable, and the presence of water is almost certainly essential.

Thus, in one series of examples, properly selected to illustrate the slaty rocks, we can watch the development of new minerals. We can observe which of these are readily produced and quickly attain to a considerable size, which are more slowly formed, or seem incapable, even if common, of much enlargement. We are thus led by inductive processes to conclusions as to the effects of pressure in the development of minerals in a mass of materials of a particular composition. In another series of rocks which has been affected by the heat of intrusive masses, we can watch the gradual growth of new constituents, as we proceed inward towards the originally heated mass, till we have passed from clay or slate to a crystalline aggregate of minerals, such as quartz, micas, andalusite, staurolite, and garnet. Similar effects may be noted in other kinds of sedimentary rock. Changes also are produced mainly by the action of water, but on this I need not enlarge.

Again, as another line of inquiry, the effects produced on igneous rocks by the same agents must be studied. Here the results which are more or less directly due to the action of water are often highly interesting, but as these are only indirectly connected with the main subject of this lecture, I content myself with a passing reference. With igneous rocks the effects of heat seem generally less important than with sedimentary; probably because the mineral constituents of the former are usually in a more stable condition than those of the latter, so that these also need only be mentioned; but the effects of pressure in some cases, especially with the more coarsely crystalline igneous rocks, are highly interesting and significant.

In a region such as the Scotch Highlands or the European Alps the rocks, in the process of mountain-making, have been obviously subjected, perhaps at more than one epoch, to tremendous pressures. The effect of these appears to have been sometimes a direct, sometimes a shearing fracture; that is to say, a mineral or rock, in the one case, has been crushed, as in a press, in the other, during the process of powdering it has been dragged or trailed out, with a movement somewhat similar to that of a viscous substance. As an example, let us take the effects produced in a granite by crushing. The grains of quartz are broken up; the crystals of felspar are first cracked and then reduced to powder; the mica flakes are bent, riven, and tattered. By pressure also the solvent power of water, already present in the rock, is increased; by the crushing its access to every fragment and its subsequent percolation are facilitated. Thus the black mica is often altered in various ways; the felspar dust is changed into white mica and chalcedonic quartz; the constituents are reduced in size and tend to assume a roughly parallel order; the mineral character and structure have been alike changed; a massive rock has been replaced by a foliated one; a coarse granite by a fine-grained quartzose or micaceous schist. This change can be demonstrated at every stage; it suggests that many foliated rocks—many gneisses and crystalline schists—may be igneous rocks of which both the mineral character and the structure have been modified by pressure.

We may presently see how far this inference can be justifiably extended, but, as a first step, the effect of pressure on one of the more basic igneous rocks must be considered. Let us take as an example a coarse-grained variety of the rock, which is familiar to us as basalt. It consists of a felspar, different from that of granite, of augite, of some iron oxide, and perhaps of olivine. In studying this rock we are confronted by greater difficulties, for, of the two dominant minerals, the felspar is rather less stable than that which occurs in granite, and the augite passes readily into hornblende. Thus, when the latter change occurs we are at first unable to determine whether it is due to pressure or to some other agent. Some petrologists, I believe, would not hesitate to appeal to the presence of hornblende in a rock such as we are considering as a proof that it had been modified by pressure. With this opinion I cannot agree. On examination of the numerous instances in which we are convinced that the hornblende is not an original constituent but has replaced augite, we notice that the former mineral is not constant in its characters. It may be granular in form; it may assume its usual crystalline shape; it may be more or less bladed or needle-like. Have these differences, we ask, any significance? In order to answer the question, specimens of hornblendic rocks must be sought in regions which obviously have been subjected to tremendous pressure, as is testified by the fact that every other rock has been more or less crushed or rolled out; others must be obtained from regions where the associated masses exhibit no signs of extraordinary disturbance, even though they may be more brittle than the subject of our study. In the former case the change may be reasonably attributed to pressure, in the latter it must be due to some other cause. Are hornblendic rocks from the one region similar in structure to those from the other? By no means. Where no evidence can be offered in favour of pressure, there the hornblende either retains wholly or almost wholly the outline of the mineral which it has replaced, or else assumes its normal prismatic form; but where an appeal to pressure seems justifiable, we find that the hornblende appears as unusually elongated prisms, blades, or even needles, and the structures of the rock as a whole can be readily recognized by a practised eye. The evidence for the latter statement is yet unpublished, but it will, I hope, appear before long.

So our investigations have led us thus far: that, in sedimentary rocks, in the presence of water, certain changes are mainly produced by heat, and certain by pressure. In the latter case, however, the new minerals, though very numerous individually, are generally minute; the longest diameter being seldom so much as one-hundredth of an inch. Even where this rule is broken, it is only by minerals which are proved by other experiments to be so readily developed that their presence on a large scale has no real significance. The rule holds also to some extent in the case of crystalline schists produced by the crushing of crystalline rocks, markedly in the case of those derived from granites and rocks of similar composition, but less conspicuously in those which were originally augitic or hornblendic. Though even here, where the decreased size of the minerals is less uniformly marked, new and distinctive structures are assumed.

I have spoken only of two or three common types of rocks, but it would be easy, did time permit, to support the principles enumerated, by quoting from a great variety of examples. There are, I believe, few, if any, important kinds of rock which have not been examined, and it appears to me demonstrated that, while pressure is a most important agent of change,[1] while many schists may be regarded as resulting from it, a considerable group remains, which are separated from the others by a very wide chasm, and this can only be jumped by deserting reason and trusting hypothesis.

In this last group of rocks (supposing no disturbances produced by subsequent pressure, for which, however, we can generally make allowance) the constituent minerals are commonly fairly large—say from about one-fiftieth of an inch upwards in diameter. Very many of these rocks, when studied in the field, exhibit every indication of a sedimentary origin. Though as a rule no original constituent grain can be certainly determined, though they are now crystalline, yet their general structure and association are inexplicable on any other supposition. They bear some resemblance to the sediments which have been altered by contact metamorphism, though they present different characters. These, moreover, remain invariable through considerable thicknesses of rock and over wide areas. The alteration is regional, not local, so that such rocks cannot be regarded as cases of simple contact metamorphism, even though heat may be suspected of having been an important agent in producing the change. But to another large series, including many of the rocks commonly called gneisses, the sedimentary origin is less easily attributed. Not a few of these in mineral composition correspond with granites, and sedimentary rock thus constituted, though not unknown, is rare. The minerals commonly exhibit a parallel or foliated and not seldom even a banded arrangement; in the latter case the layers of different mineral composition in their mutual relations and associations imitate with remarkable success the structure of a banded sedimentary rock. Even a dozen years since little doubt was entertained that this group also had a detrital origin. Occasionally, however, its members, when studied in the field, exhibited characteristics which were difficult to explain on any such hypothesis, and presented resemblances in habit to certain crystalline igneous rocks, from which, however, they were proved to differ in their microscopic structures.

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[1] It is probable that some changes of importance are produced in rocks by long-continued and repeated pressures, which are insufficient to give rise to crushing; but these I have passed by, because, as it seems to me, further evidence is needed before we can diagnose, with any certainty, the results of this particular disturbing cause.

In rocks which have crystallized from a state of fusion some of the mineral constituents usually exhibit their proper crystalline outlines; but in these others the same minerals had no definite shape, and were simply granular. Of this structure two types were observable: in the one the grains were elongated, in the other they were roundish in outline but slightly wavy or lobed. The former type was commonly found in the more distinctly banded varieties; the latter in the more massive and faintly foliated kinds which in hand-specimens were not readily distinguished from true granite.

As in rocks, no less than in living beings, diversities of structures are nature's record of a difference in history, it became a question whether these peculiarities were significant of origin or of environment. By prolonged observations the following results were established:—(1) That crystalline rocks, which could be proved, by their relation to others, to be truly igneous, sometimes exhibited banded structures. (2) That these structures, in certain cases, could not be attributed to any subsequent pressures or crushings, for no sign of them could be found in neighbouring rocks, which, from their composition and nature, ought to have yielded more readily. (3) That a faint foliation or banding, especially in the case of granitic rocks, could be sometimes detected in irruptive veins, in which cases the aforesaid granular structure was detected on microscopic examination. (4) That cases were occasionally found where a light-coloured granite had broken into a dark hornblendic rock, and the fragments of the latter had been gradually softened, elongated, and even drawn out into bands, together with the intruder, till they perfectly simulated, as already mentioned, a stratified mass. (5) That in certain of these cases, where a rock, exceptionally rich in hornblende, had been partially fused by a pale-coloured granite, a banded black-mica gneiss had been produced, indistinguishable, macroscopically and microscopically, from those which have been already mentioned.

It follows from these observations that the great group of crystalline rocks, which are connoted comprehensively as schists and gneisses, includes rocks which may have originated in one of three different ways:—(1) Some have once been molten, but have become solid under rather exceptional circumstances, probably having lost heat slowly, and having continued to move very gradually during the process of consolidation. (2) Others have been produced by the thorough alteration of sedimentary materials, in which a high temperature has been maintained for a long time, in the presence of water and under considerable pressure. (3) Others, again, have been the result of great pressure, which has acted on rocks already crystalline, and has produced mineral changes, sometimes to the complete obliteration of the original structure. The second and third of these groups are truly metamorphic rocks, to the first the term, strictly speaking, is not applicable.

As a rule, it is not difficult to distinguish between these three groups, and in all probability the ambiguities which still remain will be solved by patient and persevering work. Cases, no doubt, will occur on which no inference can be founded; cases where, from one cause or another, nature's record has become illegible. But to this disappointment the scholar and the archæologist has to submit equally with the geologist. Negative evidence of this kind has no disturbing power; any amount of it is outweighed by a single scrap of clear and positive testimony. It is generally a waste of time to puzzle over bad specimens; they are much more likely to produce a perplexed agnosticism than a rational faith; for a creed has its place in science no less than in theology.

I have mentioned one mode in which materials rather markedly different in mineral character may be, in a certain sense, interstratified and to some extent blended, but should add that recent researches render it highly probable that there are other modes in which mineral or chemical constituents may be differentiated in a magma which was once homogeneous. To discuss these would carry us into questions of crystallogenesis, which have no direct bearing on my present subject, though in these also the microscope has rendered the most valuable services by suggesting inferences and by testing theoretical conclusions; questions upon which so much light has been thrown by the researches of Guthrie, Lagorio, Sorby, and others; but I may refer in passing to the law established by Soret, that by a change of temperature a homogeneous solution may be rendered heterogeneous; since any compounds by which it is nearly saturated tend to accumulate in the colder parts. Gravitation also, when certain minerals are crystallizine from a magma, may cause them to rise or to sink, and in this way also heterogeneity may be produced. So when the mass of mingled fluids and solids is constrained to move, a streaked or banded structure may be the result produced; as in a process familiar to the glass-blower.

But when the geologist has learnt from the microscope to recognize differences of structure in crystalline rocks, and to appreciate their significance, he finds that a wider problem is presented to his mind, provided he has not been led by the fascinations of laboratory studies to despise or neglect work in the field. Granted that one group of rocks, covered by the term metamorphic, has undergone great changes since its members were first deposited or solidified, can these be connected with any phase in the earth's history? Have they any chronological significance? Even twenty years since few geologists would have hesitated to reply:—"None whatever: a rock may have undergone metamorphism at any epoch in the past. Muds and sands of Eocene, Jurassic, Carboniferous, Silurian, of any geological age, have been converted into crystalline schists. Proofs of some part of this assertion can be found even within the limits of the British Isles; it can be completely established within those of Europe." But during the last few years this hypothesis has been on its trial; witness after witness in its favour has been, so to say, brought into court, and has broken down under cross-examination. I can assert this without hesitation, for I have some personal knowledge of every notable instance in Europe which has been quoted in the debate. Microscopic study, combined with field work, has invariably discovered that some very important link in the supposed chain of proof is wanting, and has demonstrated without exception that these crystalline schists are very old; much more ancient always than any neighbouring rock to which a date can be assigned, if not older than the first rocks in which any trace of life has been found. It has been also demonstrated that sedimentary masses, after they have been buried deep beneath superimposed strata and exposed to great pressure, have emerged comparatively unchanged. Such rocks are most valuable as illustrations of the effects of dynamical and other agencies; but they are sufficiently distinct from the crystalline schists to indicate that the environment in the one case must have differed greatly from that in the other. The results of contact metamorphism prove that heat is an important agent of change; but as these also present their own marked differences, they fail to afford a complete solution of the problem.

Moreover, among ordinary sedimentary rocks, we cannot fail to notice that, as a rule, the older the rock the greater the amount of mineral change in its constituents. A good illustration of this is afforded by the Huronian system of North America, the rocks of which are rather older than the Cambrian of this country. Some of them, while still retaining distinct indications of a sedimentary origin, have become partially crystalline, and supply examples of a transition from a normal sediment to a true crystalline schist. Even the older Palæozoic rocks almost invariably exhibit considerable mineral changes, though with them it is only on a microscopic scale. Hence, taking account of all these results, we seem to be forced to the conclusion that the environment necessary for changing an ordinary sediment into a crystalline schist existed generally only in the earliest ages, and but very rarely and locally, if ever, since Palæozoic time began.

Further, in regard to those peculiar structures which, as already stated once led geologists to consider certain rocks, really of igneous origin, as metamorphosed sediments; they also appear to have been much more frequently produced in the earliest ages. They are common in association with the ordinary crystalline schists; they are found, so far as I know, rarely, if ever, with little altered sediments. The microscopic study of the coarser stratified rocks—grits, sandstones, &c.—lends some support to this view, by showing that, as we go back in time, a larger proportion of their materials, *cæteris paribus*, has been derived from crystalline rocks, and that even the fragments, obviously of sedimentary origin, exhibit signs of some mineral change; that is to say, the mudstones and sandstones in the later grits are apt to be represented in the earlier by phyllites and quartzites.

So the results of microscopic study, in alliance with, not divorced from, work in the field, lead us to the conclusion that in the early ages of this globe's history conditions generally prevailed which became gradually, perhaps even rapidly, rare and local; or, in other words, that in geology the uniformitarian doctrine must not be stated in terms wholly unlimited, though, since this was first enunciated by Lyell, nothing has been discovered to shake our faith in its general truth, or to resuscitate the catastrophic hypothesis which it replaced. But geologists are forbidden by students of physics to regard the universe as a "self-winding clock." The latter affirm, and the former frankly admit, that this globe through long ages has been losing heat by radiation; that there was a time when the temperature of its surface far exceeded that of molten iron: a temperature which now would be reached only at a depth of many miles. If this be so, the conditions under which rocks were formed on the surface of the globe in early days must have been very different from those which subsequently prevailed. Suppose, for example, this surface to have been just white-hot—namely, at a temperature much below that at which most, if not all lavas, consolidate. In that case the ocean would be vapour, and the weight of the atmosphere would be augmented by that of a shell of water of the area of the globe, and two miles in thickness; or, in other words, the atmospheric pressure would be about 350 times its present amount. If so, even a lava-flow would consolidate under a pressure equivalent to that of some 4000 feet of average rock. But after the surface temperature had become low enough to permit the seas to be gathered together, and the atmospheric pressure had become normal; after rain and rivers, winds and waves, had commenced their work; after sediments, other than the "dust and ashes" of volcanoes, had begun to accumulate; still these at a short distance below the surface would find a very different environment from that which now exists. It has been proved by Lord Kelvin that at the end of about one twenty-fifth portion of the whole time which has elapsed since the first solidification of the earth's crust, the underground temperature must have risen at nearly six times its present rate. To reach a zone, the general temperature of which is 212° F., it would now be necessary to descend, as a general rule, at least 8200 feet, and probably rather more. But in those early days the crust would have been at this temperature at a depth of about 1600 feet, and at 10,000 feet it would have risen to 1050° F., instead of 250° F., which now would be exceptionally high. To this depth many rocks, both in Palæozoic and later ages, have been buried, and they have emerged practically unchanged. Hence it follows that the latter temperature is comparatively ineffective; the former, however, could not fail to facilitate mineral changes and the development of coarsely crystalline structures.

These changes, these structures, have been produced in sedimentary rocks in the immediate neighbourhood of a large mass of intrusive igneous rock, such as a coarse granite. To what temperature the former have been raised cannot be ascertained. Suppose, however, it were 1500° F., which probably is not a very erroneous estimate, this temperature, at the epoch mentioned, would be found at a depth of 15,000 feet. It is now, probably, at least 15 miles beneath the surface. In other words, the zone at which marked mineral changes could be readily produced, quickly sank, and has long since reached a depth practically unattainable. The subterranean laboratory still exists, but the way to it was virtually closed at a comparatively early period in the earth's history.

Another effect of this rapid downward increase of temperature must not be forgotten. When it amounted to 1° F. for every 10 feet of descent, a temperature of 2000° F. would have been reached at a depth of not quite four miles. This would be rather above the melting-point of many rocks, if they were at the surface; so that, even under the pressure, they would be either very near it or imperfectly solid. If the thickness of the crust were only about four miles, flexures would be readily produced, and the effects of tidal stresses would be considerable; but even if the earth had become solid as a whole, there would have been large masses of rock, comparatively near to the surface, in an unstable condition, and thus liable locally to slow deformations, displacements, fluxional movements, and intrusion into other masses already at a high temperature, with the result of partial melting down and mutual reactions. Disturbances such as these, slow, but constantly recurring, would produce structures imitative of stratification. It is a remarkable coincidence, to say the least, that these structures are characteristic of Archæan rocks, and are extremely rare, if ever present, in those of later date.

But some geologists are so rigidly uniformitarian as to shrink from admitting that any portion of the earth's original crust can possibly be preserved. "Take time enough," they say, "and the changes can be made." But will time alone suffice for every kind of change? How long will it be before gunpowder explodes at blood-heat? But passing over this obvious difficulty, we may ask: Is there time enough? So geologists once thought, as fancy travelled back over endless æons. But they are checked by the physicist: "earth and sun alike," he affirms, "are masses subject to the laws of radiation; these countless millions of years of which you dream will bring you to a period when not only the earth, but also the whole solar system, was nebulous. All the history of your planet, physical as well as vital, so far as it can be covered by your records, must be compressed into a very moderate number of millions of years, for we have to consider the possibilities not only of a cooling earth, but also of a cooling sun." If this be so, and it seems difficult to dispute the decision; if we are forbidden to look back along "the corridors of time" till they vanish in the perspective of infinite distances, it becomes more and more probable that the whole volume of the earth's history is within our reach, and that its opening chapters will some day be deciphered.

The progress which has been made since the microscope was pressed into the service of geology augurs well for the future, if we work in a spirit of scepticism and a spirit of hope. Of scepticism, lest we trust too much either in ourselves or in even the princes of science; for experience proves that the seductive charms of phantom hypothesis may lead all alike astray from the narrow path of truth into the morasses of error. Of hope, for experience also proves that by patient labour and cautious induction many an illusion has been dispelled and many a discovery been made. Our eyes must soon grow dim, our hands become nerveless, but other workers will be found to take warning from our mistakes and to profit by our toil. The veil which shrouds the face of Nature may be never wholly withdrawn, but its fringe has been already raised; even in our own generation so much has been accomplished that the hope may be indulged of at last learning something of the history of these earliest ages, when the earth had but lately ceased to glow, and when the mystery of life began.

THE LADIES' CONVERSAZIONE OF THE ROYAL SOCIETY.

THE Ladies' *Conversazione* of the Royal Society took place on the evening of June 15 last, and in every way was a distinct success, the attendance being the greatest on record, and all the available space both for the guests and exhibits being fully occupied. The exhibits, although they included a few that were shown at the last *soirée*, were for the most part new, and the following is a brief summary of the most noticeable of them:—

Dr. H. Hicks, F.R.S., showed the remains of a mammoth found in Endsleigh Street, in March last, at a depth of only 22 feet. The bones were of enormous proportions, and in their proximity was discovered a tusk which was estimated to have been 12 feet in length.

A series of enlarged transparent sections of the fossil plants of the Coal-measures were exhibited by Prof. W. C. Williamson, F.R.S.

Most interesting were the water-colour drawings of Greek temples, &c., by Mr. F. C. Penrose, which illustrated his current investigations on the astronomical orientation of ancient Greek temples. The drawings included those of the Propylæa, the Temple of the Wingless Victory, Parthenon, west and east fronts of the Parthenon, north portico of the Erechtheum, east portico of the Theseum, and the Temple of Jupiter Olympius.

Mr. W. M. Flinders Petrie showed some excellent water-colour drawings of the pavement which he has recently discovered in the Palace of Chuenaten at Tell el-Amarna (1400 B.C.) during his recent excavations. This pavement is quite unique in Egypt, and is especially valuable owing to the marvellous treatment of the plants depicted.

The water-colour sketches exhibited by Prof. F. W. Oliver (for the Scientific Committee of the Royal Horticultural Society) illustrated some typical examples of the damage done to plants by London fog. The injuries shown, he said, were exceedingly prevalent amongst cultivated hot-house plants in the London district during this kind of weather, and extended to a considerable distance from the metropolis, cases occurring as far as Cooper's Hill and Dorking. The sulphurous acid of the fog seemed, in many cases, to have acted directly on the living substance of the foliage and leaves, producing these lesions, while in others there seemed to have been evidence of an accumulative action of the deposits of sulphuric acid.

Mr. W. Crookes, F.R.S., who at the last *soirée* repeated some of Tesla's wonderful experiments, exhibited a novelty in the form of burning nitrogen. He employed an electric current of 65 volts and 15 amperes, alternating 130 times a second, passing it through the primary of a large induction coil. From each of the secondary poles, flames became visible, and met at the centre, being composed mainly of burning nitrogen; when the terminals were separated, so that the flames could not strike across but were in consequence extinguished, it was found that by putting them nearer together a lighted taper was sufficient to re-ignite them. The temperature of the flame exceeds slightly that of a good blowpipe, and a spectroscopic examination of the flame itself shows simply a faint and continuous spectrum. Mr. Crookes pointed out that such a method of exciting an induction coil was first employed by Mr. Spottiswoode in 1880, but "it is not known, however, that any chemical explanation of the flame has before now been published."

Mr. A. A. C. Swinton showed some very interesting photographs of electrical discharges that had been obtained by simply causing the discharges to take place across the surfaces of prepared sensitive dry plates, and consequently without the intervention of any lens. The distinctive character of the figures by the two kinds of discharges were very noticeable, so also was the evidence of their oscillatory nature.

Other electrical exhibits were:—

An ingenious device for disconnecting the supplier of electricity if a dangerous voltage happened to be established in a house, and a leakage indicator for high tension currents, both exhibited by Messrs. Drake and Gorham.

Electrical discharges over prepared surfaces, by Mr. J. Wimshurst, showing that over imperfectly conducting surfaces of large area branch-like forms of flashes are produced, and with a great difference of potential sparks of seven feet in length can be attained.

High-tension electrical apparatus, by Mr. L. Pyke, for working a considerable number of vacuum tubes from one generating source, the tubes in this case being each connected with terminally connected inductors, themselves counterpoised against two external conductors connected to the terminals of the transformer.

The Director of the Royal Gardens, Kew, exhibited a specimen of a double cocoa-nut (*Lodoicea seychellarum*), with illustrations showing its germination. This palm is tall and fan-leaved, and peculiar to two of the Seychelles Islands; its fruit weighing from 25 to 30 pounds. At the germination of the seed, "the embryo is gradually pushed out of the seed by the growth of the seed-leaf (cotyledon). One end of this remains attached to the seed, and conveys to the embryo the nutriment derived from the gradual absorption of the endosperm." Three of the drawings and a model had an additional interest in that they were made by the late Major-General Gordon.

Mr. Romanes's exhibits of living rats and rabbits attracted much attention, and would perhaps have attracted slightly more if any of the former animals had by chance got astray. They were illustrative of some of the results of experimental breeding with reference to theories of heredity. The examples clearly showed that the male and female elements did not *always* so blend together that the offspring presented characters more or less intermediate between those of the parents, but that the progeny sometimes took wholly after the father or wholly after the mother.

Another animal exhibit consisted in a living specimen of a remarkable non-venomous South African snake (*Dasypeltis scabra*), from the Zoological Society of London. This animal lives solely on birds' eggs. Each egg is swallowed whole, and by a muscular contraction of the gullet, its contents flow into the stomach, while the shell is rejected by the mouth in the form of a pellet.

Among the other exhibits we may mention the systematic and simple construction of the dark absorption bands A, B, and *a* in the solar spectrum, after Mr. Higgs's photographs, by Prof. A. S. Herschel, F.R.S.; the photographs of stellar spectra, including Nova Aurigæ, Arcturus, &c., by Mr. Norman Lockyer, F.R.S.; the photographs of leguminous plants for the determination of the fixation of free nitrogen, by Sir J. B. Lawes, Bart, F.R.S., and Dr. J. H. Gilbert, F.R.S.; and an ingenious instrument for measuring the thermal expansion of very minute solid bodies up to high temperatures, and tracing the volume charge of the silicates up to and over the interval of plasticity, by Mr. J. Joly, F.R.S.

The exhibit in the Archives Room, by the Postmaster-General, was during the whole evening thoroughly appreciated, the Telephone Company's installation being the means by which the guests were able to listen to the music of Salammbo from the grand opera at Paris. Previous to the switching on of the opera, conversation was carried on with some of the officials at the Paris end, and the accuracy with which the peculiarities of the various voices were transmitted was little short of marvellous.

The lantern demonstrations also attracted considerable attention. Mr. Saville Kent and Mr. C. V. Boys, F.R.S., as at the previous *soirée*, both showed their photographic slides, those of the former dealing with coral reefs, &c., and those of the latter with flying bullets. Mr. Norman Lockyer exhibited some photographs taken both at home and foreign Observatories, illustrative of the application of photography in astro-physical researches. The slides included some beautiful photographs of stellar spectra and solar prominences, from the Paris Observatory; of the moon and Jupiter, taken with the large Lick instrument; of the nebulosity surrounding η Argûs, photographed by Dr. Gill, F.R.S.; of the great February sun-spot, taken in India and forwarded to the Solar Physics Committee; and of the spectra of Nova Aurigæ and Arcturus, taken at Kensington. The most striking slide of all was that of the great nebula of Orion, taken by Dr. Common, F.R.S., with his five-foot reflector at Ealing. The apparent brilliancy of the stars, and the wonderful tracery in the nebulous parts, appealed to the eye not so much as an image of a slide on a screen, but as a direct view of this beautiful object through the great telescope itself. The slides shown by Mr. E. B. Poulton, F.R.S., were illustrative of the methods by which the originally opaque wings of certain butterflies and moths had become transparent and usually scaleless; numerous stages in the generation of scales were also shown.

THE FOURTH CENTENARY OF COLUMBUS.

DURING the present year great celebrations will take place in Spain, Italy, and America, in memory of Columbus and his first adventurous voyage of 1492. Although no public commemoration is arranged for in this country, the Royal Geographical Society, fully conscious of the momentous nature of that first voyage, and of the enormous expansion of geographical science which has resulted from it, set apart last Monday evening for a special Columbus meeting. The usual exhibition of maps and pictures included a number of early charts of great beauty, and a fine photograph of a contemporary portrait of Columbus, recently made known by Mr. Markham. The paper of the evening, read by Mr. Clements Markham, C.B., F.R.S., was occupied with an account of recent discoveries with regard to Columbus, and the correction of many erroneous ideas widely entertained until now. As a critical summary of perhaps one of the most difficult branches of research—that into the actual life of a popular hero enhaloed with centuries of tradition—this paper is of great value. An abstract of it, and of the appendices on other fifteenth century explorers, is given below.

Much new light has been thrown upon the birth and early life of Columbus of late years by the careful examination of monastic and notarial records at Genoa and Savona.

There is no doubt as to the birthplace of Columbus. His father was a wool-weaver of Genoa, whose house was in the Vico Dritto di Ponticelli, which leads from the gate of San

Andrea to the church of S. Stefano. It was battered down during the bombardment of Genoa in the time of Louis XIV., was rebuilt with two additional stories, and is now the property of the city of Genoa.

Here Columbus was born, the date of his birth being fixed by three statements of his own, and by a justifiable inference from the notarial records. He said that he went to sea at the age of fourteen, and that when he came to Spain in 1485 he had led a sailor's life for twenty-three years. He was, therefore, born in 1447. The authorities who assign 1436 as the year of his birth rely exclusively on the guess of a Spanish priest, Dr. Bernaldez, Cura of Palacios, who made the great discoverer's acquaintance towards the end of his career.

The notarial records, combined with incidental statements of Columbus himself, also tell us that he was brought up, with his brothers and sister, in the Vico Dritto at Genoa; that he worked at his father's trade and became a "lanerio," or wool-weaver; that he moved with his father and mother to Savona in 1472; and that the last document connecting Cristofero Colombo with Italy is dated on August 7, 1473. But in spite of his regular business as a weaver, he first went to sea in 1461, at the age of fourteen, and he continued to make frequent voyages in the Mediterranean and the Archipelago—certainly as far as Chios.

When Columbus submitted his proposition for an Atlantic voyage to the Spanish sovereigns, they referred it to a committee, presided over by Father Talavera, which sat at Cordova, and condemned it as impracticable. It is generally supposed that the proposals of the Genoese were subsequently submitted to an assembly of learned persons at the University of Salamanca, and again condemned. The truth was quite different. Columbus was gifted with a charming manner, simple eloquence, and great powers of clear exposition. It was an intellectual treat to hear him recount his experiences, and the arguments for his scheme. Among those who first took an interest in his conversation, and then became a sincere and zealous friend, was the Prior of the great Dominican Convent of San Estevan, and Professor of Theology at Salamanca, who shrewdly foresaw that the most effectual way of befriending Columbus would be by affording ample opportunities of discussing the questions he raised. For this object there could be no better place than the University of Salamanca, where numerous learned persons were assembled, and where the Court was to pass the winter. The good Prior lodged his guest in a country farm belonging to the Dominicans, called Valcuebo, a few miles outside Salamanca. Hither the Dominican monks came to converse on the great deductions he had drawn from the study of scientific books, and from his vast experience, discussing the reconciliation of his views with orthodox theology. Later, in the winter, Columbus came into the city and held conferences with men of learning, at which numerous courtiers were present. These assembages for discussion—sometimes in the quiet shades of Valcuebo, sometimes in the great hall of the convent—excited much interest among the students and at Court. The result was, that the illustrious Genoese secured many powerful friends at Court, who turned the scale in his favour when the crucial time arrived. Such is the slight basis on which the story of the official decision of the Salamanca University against Columbus rests.

Captain Duro, of the Spanish Navy, has investigated all questions relating to the ships of the Columbian period and their equipment with great care; and the learning he has brought to bear on the subject has produced very interesting results. The two small caravels provided for the voyage of Columbus by the town of Palos were only partially decked. The *Pinta* was strongly built, and was originally lateen-rigged on all three masts, and she was the fastest sailer in the expedition; but she was only 50 tons burden, with a complement of eighteen men. The *Niña*, so-called after the Niño family of Palos, who owned her, was still smaller, being only 40 tons. The third vessel was much larger, and did not belong to Palos. She was called a "nao," or ship, and was of about 100 tons burden, completely decked, with a high poop and forecastle. Her length has been variously estimated. Two of her masts had square sails, the mizen being lateen-rigged. The crew of the ship *Santa Maria* numbered fifty-two men all told, including the admiral.

Friday, August 3, 1492, when the three little vessels sailed over the bar of Saltes, was a memorable day in the world's history. It had been prepared for by many years of study and labour, by long years of disappointment and anxiety, rewarded at length by success. The proof was to be made at last. To the incidents of that famous voyage nothing can be added. But we may at least settle the long-disputed question of the landfall of Columbus. It is certainly an important one, but it is by no means a case for the learning and erudition of Navarretes, Humboldts, and Varnhagens. It is a sailor's question. If the materials from the journal were placed in the hands of any midshipman in Her Majesty's Navy, he would put his finger on the true landfall within half an hour. When sailors such as Admiral Becher, of the Hydrographic Office, and Lieutenant Murdoch, of the United States Navy, took the matter in hand, they did so. Our lamented associate, Mr. R. H. Major, read a paper on this interesting subject on May 8, 1871, in which he proved conclusively by two lines of argument that Watling Island was the Guanahani or San Salvador of Columbus.

The spot where Columbus first landed in the New World is the eastern end of the south side of Watling Island. This has been established by the arguments of Major, and by the calculations of Murdoch, beyond all controversy. The evidence is overwhelming. Watling Island answers to every requirement and every test, whether based on the admiral's description of the island itself, on the courses and distances thence to Cuba, or on the evidence of early maps. We have thus reached a final and satisfactory conclusion, and we can look back on that momentous event in the world's history with the certainty that we know the exact spot on which it occurred—on which Columbus touched the land when he sprang from his boat with the standard waving over his head.

The discoveries of Columbus, during his first voyage, as recorded in his journal, included part of the north coast of Cuba, and the whole of the north coast of Española. The journal shows the care with which the navigation was conducted, how observations for latitude were taken, how the coasts were laid down—every promontory and bay receiving a name—and with what diligence each new feature of the land and its inhabitants was examined and recorded. The genius of Columbus would not have been of the same service to mankind if it had not been combined with great capacity for taking trouble, and with habits of order and accuracy.

Columbus regularly observed for latitude with Martin Behaim's astrolabe or the earlier quadrant, when the weather rendered it possible, and he occasionally attempted to find the longitude by observing eclipses of the moon with the aid of tables calculated by old Regiomontanus, whose declination tables also enabled the admiral to work out his meridian altitudes. But the explorer's main reliance was on the skill and care with which he calculated his dead reckoning, watching every sign offered by sea and sky by day and night, allowing for currents, for leeway, for every cause that could affect the movement of his ship, noting with infinite pains the bearings and the variation of his compass, and constantly recording all phenomena on his card and in his journal. Columbus was the true father of what we call proper pilotage.

On his return his spirit of investigation led him to try the possibility of making a passage in the teeth of the trade wind. It was a long voyage, and his people were reduced to the last extremity, even threatening to eat the Indians who were on board. One night, to the surprise of all the company, the admiral gave the order to shorten sail. Next morning, at dawn, Cape St. Vincent was in sight. This is a most remarkable proof of the care with which his reckoning must have been kept, and of his consummate skill as a navigator.

In criticizing the Cantino map showing Cortoreal's coastlines, Mr. Markham showed that absurd mistakes had been made, not by the voyager or his pilots, but by the cartographer, and subsequent commentators. Vespucci's description of his "first voyage" in 1797, was subjected to very thorough criticism, and shown, in spite of the arguments of authors who have tried to support the veracity of that ingenious romancer, to have been a pure fabrication. Little or no credit could be given to Vespucci in any case, as he was forty-eight years old on first going to sea, and in those days apprenticeship from boyhood was indispensable for a knowledge of seamanship.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Science Examiners have issued the following Class Lists:—

Chemistry.—First Class: C. L. Fort (New), R. E. Hughes

(Jesus), G. Ingham (Merton), A. L. Ormerod (New). Second Class: D. Berridge (Wadham), P. Henderson (Queen's), A. E. Richardson (Wadham), F. R. L. Wilson (Keble). Third Class: C. J. M. Parkinson (Jesus), H. Wynne-Finch (New). Fourth Class: S. Wellby (Trinity).

Physiology.—First Class: P. S. Hichens (Magdalen), H. H. G. Knapp (non-Coll.), A. C. Latham (Balliol), E. Mallam (Magdalen), W. Ramsden (Keble). Second Class: G. J. Conford (Christ Church), E. Stainer (Magdalen). Third Class: S. B. Billups (non-Coll.). Fourth Class: J. S. Clouston (Magdalen).

Physics.—First Class: S. A. F. White (Wadham). Second Class: G. M. Grace (Jesus). Third Class: none. Fourth Class: F. W. Bown (University), J. C. W. Herschel (Christ Church).

Morphology.—First Class: R. W. T. Günther (Magdalen).

Botany.—Second Class: O. V. Darbishire (Balliol).

Women:—Louisa Woodcock is placed in the Second Class, Morphology.

University Extension.—In a Convocation held on Tuesday the following persons were declared on a scrutiny to be duly elected as delegates, under the provisions of the statute Of the delegates for the extension of teaching beyond the limits of the University:—H. J. Mackinder, M.A., Student of Christ Church; W. W. Fisher, M.A., Corpus Christi College, Aldrichian Demonstrator of Chemistry; J. F. Bright, D.D., Master of University College; A. Sidgwick, M.A., Fellow of Corpus Christi College; J. Wells, M.A., Fellow of Wadham College; and the Rev. W. Lock, M.A., Fellow of Magdalen College.

The Encænia.—In a Convocation holden in the Sheldonian Theatre on Wednesday, June 22, the degree of D.C.L. (*honoris causâ*) was conferred upon the following persons:—

His Excellency, William Henry Waddington, Ambassador Extraordinary and Minister Plenipotentiary from the French Republic at the Court of St. James, Honorary Fellow of Trinity College, Cambridge, Hon. LL.D.

His Highness the Thakore of Gondal.

The Very Rev. Henry George Liddell, D.D., late Dean of Christ Church.

Edward Caird, M.A., Professor of Moral Philosophy in the University of Glasgow, formerly Fellow of Merton.

W. M. Flinders Petrie.

The Rev. John Gwynn, D.D., Regius Professor of Divinity in the University of Dublin.

Daniel John Cunningham, M.D., Professor of Anatomy and Chirurgery in the University of Dublin.

Edward Dowden, LL.D., Erasmus Smith's Professor of Oratory in the University of Dublin.

The Rev. John P. Mahaffy, D.D., Professor of Ancient History in the University of Dublin.

Benjamin Williamson, M.A., Sc.D., Fellow of Trinity College, Dublin.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 2.—"On Current Curves." By Major R. L. Hippisley, R.E. Communicated by Major MacMahon, F.R.S.

(1) Starting with the equations

$$i = \frac{E}{R}\left(1 - e^{-\frac{Rt}{L}}\right)$$

and

$$i = \frac{E}{\sqrt{(R^2 + p^2L^2)}}\sin(pt - \theta),$$

which represent the curves of currents in circuits *without* iron cores, according as the impressed E.M.F. is constant or varying as sin pt, we can determine the curves according to which the current rises and falls in circuits *with* iron cores, both for a constant impressed E.M.F. and for a sinusoidal E.M.F.

(2) In the first case, with constant applied E.M.F., we can determine by Lagrange's formula of interpolation the equation to the (B, H) curve of the particular core under consideration. This will be of the form

$$B = a_0 + a_1H + a_2H^2 + \ldots + a_nH^n,$$

where n is one less than the number of observed simultaneous values of B and H from which the equation is calculated. Substituting in the equation

$$E - \frac{dB}{dt} = Ri,$$

we get, after integration,

$$t = b_0 \log\frac{E}{E - Ri} - b_1 i - b_2 i^2 - \&c., \text{ to } n + 1 \text{ terms},$$

b_0, b_1, b_2, &c., being numerical. The paper gives b_0, b_1, b_2, &c., in terms of the constants of the circuit, &c.

The corresponding equation when the E.M.F. is removed and the current is dying away is

$$t = c_0 \log\frac{E}{Ri} - c_1 i - c_2 i^2 - \&c. + \text{a constant}.$$

From these two equations the curves can be plotted.

(3) This method is not applicable to the case in which the impressed E.M.F. is sinusoidal, on account of difficulties of integration. But both cases can be treated in another way:—Take a series of points on the (B, H) curve of the iron core, such that the chords joining them practically coincide with the curve itself. Let B_κ, H_κ, and $B_{\kappa+1}$, $H_{\kappa+1}$, be the co-ordinates of two consecutive points. The equation to the curve between these points is approximately

$$B = m_{\kappa+1}H + \text{constant},$$

where

$$m_{\kappa+1} = \frac{B_{\kappa+1} - B_\kappa}{H_{\kappa+1} - H_\kappa}.$$

Substituting in the equation

$$E - \frac{dB}{dt} = Ri,$$

we get, after integration,

$$t_{\kappa+1} = t_\kappa + \frac{m_{\kappa+1}L}{R}\log\frac{E - Ri_\kappa}{E - Ri_{\kappa+1}},$$

which is true to a very close approximation for any simultaneous values of t and i between the above limits. From this equation, by determining the various values of m, and remembering that t_0 and i_0 are both zero, we can determine in succession the times at which the current has the known values 0, $\frac{H_1}{L}$, $\frac{H_2}{L}$, . . . &c., and the current curve can be plotted.

On making $E = 0$ in the original differential equation, and observing the proper limits, we get

$$t_{n+1} = t_n + \frac{m_{n+1}L}{R}\log\frac{H_n}{H_{n+1}}$$

as the equation to the curve representing the dying away of the current when the E.M.F. is withdrawn; m_n, m_{n+1} being determined from the descending (B, H) curve.

(4) When the impressed E.M.F. is sinusoidal, we substitute for dB/dt in the equation

$$E\sin pt - \frac{dB}{dt} = Ri,$$

having determined the various values of dB/dt, as in the foregoing.

As by the present method the value of m changes *abruptly* from m_κ to $m_{\kappa+1}$, we must employ the *general* solution of the above, which for the interval t_κ, $t_{\kappa+1}$, is

$$i = \frac{E}{\sqrt{(R^2 + m_{\kappa+1}{}^2p^2L^2}}\sin(pt - \theta_{\kappa+1}) + A_{\kappa+1}e^{-Rt/m_{\kappa+1}L},$$

in order that the current at the commencement of the interval t_κ, $t_{\kappa+1}$, may have the same value which it had at the end of the interval $t_{\kappa-1}t_\kappa$. The complementary function

$$A_{\kappa+1}e^{-Rt/m_{\kappa+1}L},$$

enables us to insure this condition; for, by taking the constant $A_{\kappa+1}$ of such a value that the above equation is satisfied when $i = i_\kappa$ and $t = t_\kappa$, there is no abrupt change in the current. The complementary function, in fact, represents the gradual dying away of whatever excess or defect of current there would be in the circuit when m changes.

This equation is true for all values of i between i_κ and $i_{\kappa+1}$; and, therefore, enables us to find the time, $t_{\kappa+1}$, at which the current attains the known value $H_{\kappa+1}/L$.

By changing κ into $\kappa + 1$, we obtain similarly the time $t_{\kappa+2}$ at which the current has the value $H_{\kappa+2}/L$, and so on.

Thus the determination of $t_{\kappa+1}$ is made to depend upon t_κ, and in order to make a start we must assume that the value of i is known for some definite value of t. It is not of much consequence what assumption, within reason, is made, as, though the calculated curves will vary with the assumption made, they will all eventually merge into the true periodic current curve at some point which will be exhibited when the *first* evanescence of $Ae^{-Rt/mL}$ takes place.

As this complementary function is a continually decreasing quantity, it becomes negligible when it is allowed time enough. This opportunity is afforded when the straighter portions of the (B, H) curve are reached.

In the paper are given diagrams showing the plotted curves of current calculated from the above equations, together with tables of calculated values.

"The Conditions of the Formation and Decomposition of Nitrous Acid." By V. H. Veley.

The main points of this inquiry may briefly be summarized as follows:—

(1) The formation of the impurity of nitrogen peroxide in nitric acid, imparting to it the well-known yellow tint, takes place in the case of the more concentrated acid, even at a temperature of 30°, and of the less concentrated acids at from 100°–150°, even when the acid is not unduly exposed to sunlight.

(2) The reaction between nitric oxide and nitric acid may be regarded as reversible, thus:—

$$2NO + HNO_3 + H_2O \rightleftarrows 3HNO_2,$$

provided that the acid be sufficiently dilute, and the temperature sufficiently low. Under these conditions equilibrium is established between the masses of nitric acids when the ratio of the former to the latter is, roughly speaking, as 9 : 1. The actual ratio varies slightly on the one side or the other, according to the conditions of the experiments. With more concentrated acids and at higher temperatures the chemical changes taking place are more complicated, and the decomposition of the acid more profound.

(3) The decomposition of solutions containing both nitric and nitrous acids is also investigated; the rate of the change is shown to be proportional to the mass of the nitrous acid undergoing change. The curve representing the amount of chemical decomposition in terms of the mass present is shown to be hyperbolic, and illustrative of the law

$$\text{(I.)}\ \frac{dC}{dT} = -\frac{C^2}{M}.$$

This holds good, whatever be the method employed for the production of the nitrous-nitric acid solution.

The observed values for C or the concentration of the nitrous acid are concordant with those calculated according to the above differential equation within the limits of experimental error.

The rate is dependent upon the ratio of the masses of the nitrous and nitric acid, being the more rapid, the greater the proportion of the former to that of the latter.

In the particular case of the liquid prepared from nitric oxide and nitric acid, wherein the reproduction of solutions of similar concentration presents less difficulty, it is shown that as the temperature increases in arithmetical the rate of change increases in geometrical proportion, in accordance with the equation

$$\text{(II.)}\ v_t = v_{t_1} k^{(t-t_1)},$$

the value for k being 0·158.

Finally, though the nitrous-nitric acid solutions behave in a similar manner as regards the diminution of the mass of the nitrous acid, yet, in other respects, such as evolution of gases and the action upon metals, they are dissimilar.

"On the Method of Examination of Photographic Objectives at the Kew Observatory." By Major L. Darwin. Communicated by Captain Abney, R.E., F.R.S.

The paper describes the method of examination of photographic objectives which has been adopted at the Kew Observatory, chiefly on the recommendation of the author. In selecting and devising the different tests, Major Darwin acted in co-operation with Mr. Whipple, the Superintendent of the Observatory, and was aided by consultations with Captain Abney.

The object of the examination is to enable any one, on the payment of a small fee, to obtain an authoritative statement or certificate as to the quality of an objective for ordinary purposes.

An example is first given of a "Certificate of Examination," such as would be obtained from Kew, and then the different tests are discussed in detail. The following are the different items in the Certificate of Examination, or the various tests to which the objective is subjected:—

(1) to (4) None of this information forms part of the result of the testing.

(5) *Number of External Reflecting Surfaces.*

(6) *Centering in Mount.*

(7) *Visible Defects, such as Veins, Feathers, &c.*

(8) *Flare Spot.*

(9) *Effective Aperture of Stops*, which is given for each one supplied with the objective. In recording the results, it is proposed that the system of numbering recommended by the International Photographic Congress of Paris of 1889 should be adopted.

(10) *Angle of Cone of Illumination, &c.*

(11) *Principal Focal Length.*—This is found by revolving the camera through a known angle, and measuring the movement of the image of a distant object on the ground glass; with the Testing Camera it is so arranged that an angular movement can be given with great ease and accuracy, and that the angle is such that half the focal length is directly read off on a scale on the ground glass. The observation is made when the image is at a point some 14 degrees from the axis of the objective, and the effect of distortion and curvature of the field is discussed; it is proved that the focal length thus obtained, even though it may not be identical with the principal focal length as measured on the axis, is nevertheless what the photographer in reality wants to ascertain.

(12) *Curvature of the Field.*

(13) *Distortion.*—This test depends in principle on ascertaining the sagitta or deflection in the image of a straight line along one side of the plate. In the discussion it is shown that to give the total distortion near the edge of the plate would not answer practical requirements, and that the proposed method of examination does give the most useful information that can be supplied.

(14) *Definition.*—This is found by ascertaining what is the thinnest black line the image of which is just visible when seen against a bright background. It is shown that this is the best method that could be devised of measuring the defining power of an objective, and that it is not open to serious objections on theoretical grounds.

(15) *Achromatism.*—In the Certificate is recorded under this heading the difference of focus between an object when seen in white light and the same when seen in blue or red light.

(16) *Astigmatism.*—This test is performed by measuring the distance between the focal lines at a position equivalent to the corner of the plate, and by calculating from the result thus obtained the approximate diameter of the disk of diffusion due to astigmatism.

(17) *Illumination of the Field.*—The method of examination, which is due to Captain Abney, is described.

"On Certain Ternary Alloys. Part VI. Alloys containing Aluminium, together with Lead (or Bismuth) and Tin (or Silver)." By C. R. Alder Wright, D.Sc., F.R.S., Lecturer on Chemistry and Physics in St. Mary's Hospital Medical School.

The experiments described in this paper are a continuation of the previous researches on the miscibility of molten metals under such conditions that whereas two of the metals, A and B, will not mix together in all proportions, the third, C, is miscible in all proportions with either A or B severally. The alloys now investigated are those where A is lead (or bismuth); B, aluminium; and C, tin (or silver). They show considerable analogy with, and resemblance to, those previously described containing the same metals as A and C respectively, but zinc instead of aluminium as B; but certain differences are noticeable: thus the substitution of aluminium for zinc invariably *raises the critical curve*, causing it to lie *outside* its former position, this being observed whether the heavy immiscible metal, A, be lead or bismuth, and whether the solvent metal, C, be tin or silver. On the other hand, the substitution of bismuth for lead always *depresses the critical curve*, causing it to lie *inside* its former position; this being equally observed whether the lighter immiscible metal, B, be zinc or aluminium, and whether the solvent metal, C, be tin or silver. In the case of the metals bismuth-zinc-silver and lead-zinc-silver, peculiar bulges (inwards and outwards) were noticed in certain parts of the critical curve, due to the formation of definite atomic compounds, $AgZn_5$ and Ag_4Zn_5; no corresponding indications are observed when aluminium replaces zinc in these mixtures, whence apparently similar atomic combinations of silver and aluminium are not formed. On the other hand, lead-zinc-tin and lead-aluminium-tin alloys correspond sharply with each other in that they are the only alloys yet examined where the direction of slope of the tie lines is not the same throughout; in each case the lower ties slope to the left (lead side), and the upper ones to the right (zinc side); the point where the angle of slope of the lower ties is a maximum corresponds in each case with a ratio between lead and tin in the heavier alloys formed approximating pretty closely to that indicated by the formula Pb_3Sn, suggesting that the sloping of the lower ties is due to the formation of this definite atomic compound. The upper ties in each case exhibit a tendency to converge towards a point on the right-hand side of the curve, approximately where the ratios of zinc to tin and aluminium to tin respectively are those indicated by the formulæ Zn_4Sn, and Al_4Sn; suggesting the existence of these definite compounds.

In the course of the experiments, it is shown incidentally that bismuth and aluminium are practically immiscible when molten: at about 900° C. bismuth dissolves less than 0·1 per cent. of aluminium, whilst aluminium dissolves about 2·0 per cent. of bismuth. The binary alloys of bismuth and aluminium stated by previous observers to exist are simply more or less intimate intermixtures of the two metallic solutions.

"On the Theory of Electrodynamics as affected by the nature of the Mechanical Stresses in Excited Dielectrics." By J. Larmor.

The various theories of electrodynamics are examined from the standpoint of their ability to explain the experimental facts as to pressures in liquid dielectrics which have been made out by Quincke and other experimenters.

The principal conclusions are as follow:—

(1) It follows from the experimental results that the stress in an excited fluid dielectric between two condenser plates consists, at any rate to a first approximation, of a tension along the lines of force and an equal pressure in all directions at right angles to them, superposed upon such stress as would exist in a vacuum with the same value of the electric force.

(2) It follows from experiments that the numerical value of these additional equal tensions and pressures is, at any rate to a first approximation, $(K - 1)F^2/8\pi$, where F is the electric force, and K the inductive capacity.

(3) Such a distribution of equal tension and pressure is necessarily the result of a uniform volume distribution of energy in the dielectric, irrespective of what theory is adopted as to its mode of excitation.

(4) If we consider the mode of excitation to be a *quasi*-magnetic polarization of its molecules, the numerical magnitude of these stresses should be

$$\frac{K - 1}{8\pi}F^2\left(1 + \lambda\frac{K - 1}{4\pi}\right),$$

where λ is a coefficient which depends on the molecular discreteness of the medium, and is probably not very different from the value $\frac{4}{3}\pi$. A discrete polarization of the molecules does not account for the stress, so far as this coefficient is concerned.

(5) The stress which would exist in a vacuum dielectric is certainly due in part to a volume distribution of energy, as is shown by the propagation of electric waves across a vacuum. There is thus no reason left for assuming any part of it to be due to a distribution of energy at its two surfaces, acting directly on each other at a distance. There is therefore ground for assuming a purely volume distribution of energy in a vacuous space, leading to a tension $(1/8\pi)F^2$ along the lines of force, and a pressure $(1/8\pi)F^2$ at right angles to them.

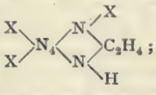
(6) The *quasi*-magnetic polarization theory rests on the notion of a dielectric excited by a surface charge on the plates, and therefore involves a surface-distribution of energy, unless in the extreme case when the absolute value of K is very great; in that case a slight surface-charge produces a great polarization effect, and in the limit the polarization may be taken as self-excited. Thus the absence of a surface-distribution of energy leads to Maxwell's displacement-theory, in which all electric currents are circuital, and the equations of electrodynamics are therefore ascertained.

(7) It appears that even this limiting polarization theory must be replaced, on account of the stress-formula in (4), by some dynamical theory of displacement of a more continuous character.

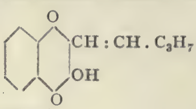
"The Hippocampus." By Dr. Alex. Hill.

Observations upon the brains of various aquatic mammals which show that, when the sense of smell is completely absent, as judged by the total suppression of the olfactory bulb and nerves, the essential constituent of the "hippocampus," the fascia dentata, is absent also. Amongst other mammals the fascia dentata varies in development as the olfactory bulb.

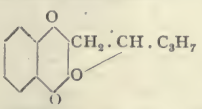
Chemical Society, June 2.—Dr. W. H. Perkin, F.R.S. Vice-President, in the chair.—The following papers were read:—Ethylene derivatives of diazoamido-compounds, by R. Meldola and F. W. Streatfeild. The authors find that ethylene diazoamides result from the action of ethylene dibromide and caustic alkali on diazoamides dissolved in alcohol. The products thus obtained have the general formula—



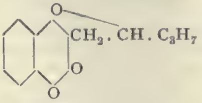
mixed ethylene-diazoamides can also be obtained. These compounds are very stable, and are decomposed by prolonged contact with concentrated hydrochloric acid at ordinary temperatures.—The action of light on silver chloride, by H. B. Baker. The small loss in weight which silver chloride undergoes on exposure to light has led the author to investigate whether oxygen is absorbed at the same time that chlorine is evolved, Robert Hunt having long ago stated that such an absorption does occur. Silver chloride was placed in a bulb connected with a long tube standing over caustic potash solution; the atmosphere consisted of air or oxygen. On exposing this apparatus to light, the liquid rose in the tube, showing that oxygen had been absorbed. The proportion in which the elements silver, chlorine, and oxygen were contained in the darkened substance was then determined. The results agree approximately with the formula Ag_2ClO. The experimental difficulties in the way of an exact determination of the composition of the darkened product are very great, owing to the fact that the dark substance is mixed with an enormous quantity of unchanged silver chloride. The product of exposure to light never contains more than 0·1 gram of the dark-coloured substance per 50 grams of unaltered silver chloride. Another cause of inaccuracy complicates the result if the analyses be not made immediately after exposure; the darkened substance turns white again if left in the dark, probably owing to the formation of another oxychloride. The thoroughly dried darkened substance yields water on reduction in pure hydrogen, and also evolves oxygen on treatment with pure chlorine. The results of determinations of the constituents of the darkened product made by various analytical methods agree as well as could be expected. Silver chloride does not darken when exposed to light in absence of oxygen. No darkening was observed in a vacuum, in carbon dioxide, or in carefully purified carbon tetrachloride. It is, however, difficult to eliminate traces of alcohol, carbon disulphide, &c., from carbon tetrachloride, and the darkening caused by these impurities has hitherto been confounded with that caused by oxygen. Darkened silver chloride dissolves completely in boiling potassium chloride solution, and the solution so obtained contains caustic potash. The production of this free alkali seems to prove conclusively that oxygen is present in the darkened substance in the combined state.—The estimation of slag in wrought iron, by A. E. Barrows and T. Turner. Cast iron comparatively rich in non-metallic elements is known to afford a greater yield of puddled bar than do purer samples of iron. The loss on reheating and rolling into finished iron is, however, also greater. This difference has been attributed to intermingled slag. The authors prepared four samples of iron, viz. best bar, best sheet from the same bar, common bar, and common sheet from the same. Pig iron of known composition was used; the yield of common puddled bar was 6·5 per cent. greater than that of the other, but the loss on reheating was also 1·5 per cent. greater, leaving a balance of 5 per cent. in favour of the common iron. The results of analyses show that the silicon is equally, and very slightly, reduced in each case, whilst the phosphorus was much reduced in common iron, and but scarcely affected in best. This does not favour the view that much more slag is removed in one case than in the other. The authors conclude that for practical purposes the weight of slag in best and common iron may be taken as identical, and that on reheating and rolling each loses about the same weight of slag. The additional loss noticed on reheating impure iron is due chiefly to the elimination of phosphorus, probably in the form of ferrous phosphate. On attempting to estimate the slag by combustion in chlorine, a method already employed for cast iron, it was found that the slag was readily attacked by the gas at a very low red heat. An examination of the behaviour of a number of iron ores and slags showed that action occurs according to the equation $3FeO = Fe_2O_3 + Fe$; the free iron subliming as ferric chloride.—Corydaline, ii., by J. J. Dobbie and A. Lauder. Analyses of salts of corydaline are given in support of the formula $C_{22}H_{29}NO_4$, originally proposed by the authors for this alkaloid. The alkaloid employed by them is identical with that extracted by Adermann from the roots of *Corydalis cava*. Corydaline yields four molecular proportions of methyl iodide on treatment with concentrated hydriodic acid; the hydriodide of a new base $C_{18}H_{21}NO_4,HI$ is also obtained. The conclusion that corydaline contains four methoxy-groups is confirmed by the inability of the authors to obtain any definite reaction with phenylhydrazine or phosphorus pentachloride.—The action of bromine on allylthiocarbimide, by A. E. Dixon. Allylthiocarbimide readily combines with bromine, yielding dibromopropylthiocarbimide as an oily liquid which decomposes on distillation under ordinary pressures. This compound does not afford dibromopropylphenylthiourea when treated with aniline, but the two substances react with elimination of hydrogen bromide and formation of a compound of the formula $C_{10}H_{11}BrN_2S$, probably *n*-phenylbromotrimethylene-ψ-thiourea.—The hydrolytic functions of yeast, Part i., by J. O'Sullivan. It is generally stated, on the authority of Berthelot, that the water in which yeast has been washed possesses, like yeast itself, the power of hydrolyzing cane sugar, and that the active substance can be precipitated from the solution by means of alcohol. The author shows, however, that healthy yeast yields none of its invertase to water in which it is washed. When such yeast is placed in contact with sugar, hydrolysis is effected solely under the immediate influence of the plasma of the cell, no invertase leaving the cell while hydrolysis is taking place. A detailed account is given of experiments carried out under various conditions, which show that water which had been in contact with highly active yeast for various times had no hydrolytic power, although on the addition of a mere trace of invertase, it at once became active. The author therefore concludes that the resolution of cane sugar under the influence of yeast is entirely due to zymic hydrolysis.—The constitution of lapachic acid (lapachol) and its derivatives, by S. C. Hooker. Lapachic "acid" is found in a crystalline state in the grain of a number of South American woods, and derives its name from the lapach tree, which is plentiful in the Argentine Republic. On treatment with sulphuric acid, lapachol is converted into an isomeride generally known as lapachone. The author proposes to term this latter substance β-lapachone, it being a derivative of β-naphthaquinone. When lapachol is treated with concentrated hydrochloric acid, α-lapachone, a derivative of α-naphthaquinone is obtained. The author assigns the following constitutional formulæ to these three isomerides—



Lapachol.



α-Lapachone.



β-Lapachone.

It is shown that Paterno's isolapachone in reality contains less hydrogen than the lapachones, and is doubtless a β-naphthaquinone-propyl-furfuran.

Linnean Society, June 2.—Prof. Stewart, President, in the chair.—The Vice-Presidents for the year having been nominated by the President, a vote of thanks to the officers of the Society was proposed by Mr. Thomas Christy, seconded by Mr. C. J. Breese, and carried.—Mr. H. Bernard exhibited specimens and made remarks on the probably poisonous nature of the hairs and claws of an Arachnid (*Galeodes*).—On behalf of Capt. Douglas Phillott there was exhibited a curious case of malformation in the beak of an Indian parrakeet, *Palæornis torquatus*. The upper mandible was so abnormally decurved as almost to penetrate between the rami of the lower mandible, and although the bird was in good condition at the time it was shot by Capt. Phillott at Dera Ismail Khan, Punjab, in March last, it was evident that had it not been killed then, death must have soon ensued from a severance of the trachea by the sharp extremity of the prolonged mandible.—Mr. D. Morris exhibited, and made some very instructive remarks on, plants yielding Sisal hemp in the Bahamas and Yucatan, and pointed out their distribution and mode of growth. He also exhibited and described the preparation of a gut silk from Formosa and Kiungchow.—Mr. Scott Elliott gave a brief account of a journey he had recently made to the west coast of Africa, and described the character of the vegetation of the particular region explored, and the plants collected by him.—Mr. Jenner Weir exhibited and made remarks on a species of Psyche.—On behalf of Mr. Ernest Floyer, a paper was read by the Secretary on the disappearance of certain desert plants in Egypt through the agency of the camel.—Mr. F. Perry Coste gave an abstract of a paper on the chemistry of the colours in insects, chiefly Lepidoptera. The paper was criticized by Prof. Meldola, who was unable to accept the views expressed, the results of the experiments made being, in his opinion, inconclusive.—The meeting was brought to a close by the exhibition of an excellent oxyhydrogen lantern, recently presented to the Society by Dr. R. C. A. Prior, when Dr. R. B. Sharpe exhibited a number of coloured slides of birds designed to illustrate the interesting subject of mimicry and protective coloration.

Geological Society, June 8.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—The Tertiary microzoic formations of Trinidad, West Indies, by R. J. Lechmere Guppy. (Communicated by Dr. H. Woodward, F.R.S.) After giving an account of the general geology of the island, and noticing previous memoirs devoted to that geology, the author describes in detail the characters of the Naparima Beds, to which he assigns an Eocene and Miocene age. He considers that the Nariva Marls are not inferior to but above the Naparima Eocene Marls, and are actually of Miocene date. Details are given of the composition and characters of the "argiline," the foraminiferal marls occasionally containing gypsum, and the diatomaceous and radiolarian deposits of Naparima. The Pointapier section is then described, and its Cretaceous beds considered, reasons being given for inferring that there was no break between the Cretaceous and Eocene rocks of the Parian area. Detailed lists of the foraminiferal faunas of the marls are given, with notes. The author observes that the Eocene molluscan fauna of Trinidad shows no near alliances with other known faunas, thus differing from the well-known Miocene fauna of Haiti, Jamaica, Cuba, Trinidad, and other localities. Only one mollusk is common to the Eocene and Miocene of the West Indies. The shallow-water Foraminifera are found in both Eocene and Miocene, whilst the deep-water Foraminifera are nearly all of existing species. It would appear that during the Cretaceous and Eocene periods a sea of variable depth (up to 1000 fathoms) occupied the region now containing the microzoic rocks of Trinidad, whilst a mountain-range (which may be termed the Parian range) extended continuously from the north of Trinidad to the littoral Cordillera of Venezuela, forming the southern boundary of the Caribbean continent, and possessing no large streams to transport mechanical sediment into the Cretaceo-Eocene sea which opened eastward into the Atlantic. An appendix by Mr. J. W. Gregory deals with the microscopic structure of the rocks. The reading of this paper was followed by a discussion, in which the President, Dr. H. Woodward, Mr. J. W. Gregory, Mr. Vaughan Jennings, and Dr. Hinde took part.—The Bagshot Beds of Bagshot Heath (a rejoinder), by the Rev. A. Irving. — Notes on the geology of the Nile Valley, by E. A. Johnson Pasha and H. Droop Richmond. (Communicated by Norman Tate.) The rocks on either side of the Nile are chiefly Eocene (and Cretaceous?) from Cairo to Esneh; south of this is sandstone, which the authors believe to be Carboniferous, and to yield possible indications of coal, reaching to near Assouan, where it meets the granite and basalt of that region; a few miles south the sandstone begins again and continues to Wady Halfa, broken only by granite dykes. The granite is intrusive into and alters the sandstone, whilst the latter reposes upon the basalt and in some cases was deposited against upstanding basaltic masses. Unmistakable lavas occur near the Nile east of Minieh and west of Assiout. A description of some remarkable faults is given, and various minerals are noticed as occurring in the sedimentary rocks and the bed of an ancient river.

Mathematical Society, June 9.—Prof. Greenhill, F.R.S., President, in the chair.—Prof. Henrici exhibited a model of movable hyperboloids of one sheet. In 1873 he gave a student at University College the problem to construct a model of a hyperboloid of one sheet by fixing three sticks anyhow, placing others so as to cut these, and tying them together wherever they met. He told the student that the system would soon become rigid, but was surprised to find that this was not the case. It was easy to see the reason of this fact, and thus he established the theorem: If the two sets of generators of a hyperboloid be connected by articulated joints wherever they meet, then the system remains movable, the hyperboloid changing its shape. It was also soon found that each point moves during this deformation along the normal to the momentary position of the surface, and that therefore the different positions of the surface constitute a system of confocal hyperboloids. He then made a model such that the generators represented by sticks meet at points which lie on lines of curvature of the hyperboloids. These describe, therefore, confocal ellipsoids and hyperboloids of two sheets. In January 1874, Prof. Henrici exhibited this model at a meeting of the Society. Shortly afterwards a student made two copies of this model, and these were fastened together in such a manner that both could move together, remaining always confocal. It was this last model that was now shown. The properties of the movable hyperboloid became more widely known through a question which Prof. Greenhill set in 1878 at the Mathematical Tripos Examination, and this led Prof. Cayley to give a solution of it in the *Messenger of Mathematics*. Since that time several French mathematicians have made further investigation of the property in question. MM. Darboux and Mannheim, in particular, have made beautiful application of the deformable hyperboloid to the motion of a gyrating rigid body.—The following further communications were made:—The second discriminant of the ternary quantic, $x'u + y'v + z'w$, by Mr. J. E. Campbell. If the ordinary discriminant of this quantic in x, y, z, be formed, the result will be a quantic in x', y', z'. The discriminant of this latter the writer believes vanishes identically with certain exceptions. Prof. Henrici referred the author to a paper by himself in vol. ii. of the Society's Proceedings.—On the reflection and refraction of light from a magnetized transparent medium, by A. B. Basset, F.R.S. The object of this paper is to apply the theory of gyrostatically loaded media, to investigate the reflection and refraction of light at the surface of a magnetized transparent medium. This subject has been partially discussed by Mr. Larmor in a paper communicated to the Society last December, in which he has obtained the equations of motion of the medium; but the paper in question contains (Mr. Basset thinks) a certain amount of vague and obscure argument, founded upon general reasoning, which is calculated to envelop the subject in a cloud of mystery, rather than to enlighten the understanding. He, therefore, finds it necessary to write out the theory *de novo*, and to enter into a careful discussion respecting the boundary conditions. The principal results are as follows: When the magnetic force is parallel to the reflector, and also to the plane of incidence, the expressions for the amplitudes of the reflected light are the same as those which he obtained by means of an extension of the electromagnetic theory (see *Phil. Trans.*, 1891, p. 371); but when the magnetic force is perpendicular to the reflector, the above-mentioned expressions are of the same form as those furnished by the electromagnetic theory, with the exception that the signs of the magnetic terms are reversed. An experimental test of the relative merits of the two theories might probably be obtained by means of certain experiments performed by Prof. Kundt (*Berlin. Sitzungsberichte*, July 10, 1884; translated *Phil. Mag.*, October 1884), but the mathematical work, although presenting no difficulty, would be somewhat laborious. Having worked out these results, he endeavours to obtain a theoretical explanation of Kerr's experiments, on reflection from a magnet, by combining the theory of gyrostatically loaded media with the theory of metallic reflection, explained in his book on "Physical Optics," chapter xviii. sections 386-87; but the results are not entirely satisfactory. This, however, is not surprising, inasmuch as the theory of gyrostatically loaded media takes no account of the statical effects of magnetization.—Note on approximate evolution, by Prof. Lloyd Tanner. This note supplies a deficiency in a paper (Math. Soc. Proc., vol. xviii.) in which Prof. Hill pointed out the incorrectness of the rule for contracting the processes of finding the square and cube roots of a number—namely, it gives a practical test for determining the cases when the rule can, and when it cannot, be safely applied.—A proof of the exactness of Cayley's number of seminvariants of a given type, by Mr. E. B. Elliott, F.R.S.—Further note on automorphic functions, by Prof. W. Burnside.

Royal Meteorological Society, June 15.—Dr. C. Theodore Williams, President, in the chair.—The following papers were read:—English climatology, 1881-1890, by Mr. F. C. Bayard. This is a discussion of the results of the climatological observations made at the Society's stations, and printed in the *Meteorological Record* for the ten years 1881-1890. The instruments at these stations have all been verified, and are exposed under similar conditions, the thermometers being mounted in a Stevenson screen, with their bulbs 4 feet above the ground. The stations are regularly inspected, and the instruments tested by the Assistant Secretary. The stations now number about eighty, but there were only fifty-two which had complete results for the ten years in question. The author has discussed the results from these stations, and given the monthly and yearly means of temperature, humidity, cloud, and rainfall. His general conclusions are:—(1) With respect to mean temperature, the sea coast stations are warm in winter and cool in summer, whilst the inland stations are cold in winter and hot in summer. (2) At all stations the maximum temperature occurs in July or August, and the minimum in December or January. (3) Relative humidity is lowest at the sea coast stations, and highest at the inland ones. (4) The south-western district seems the most cloudy in winter, spring, and autumn, and the southern district the least cloudy in the summer months, and the sea coast stations are, as a rule, less cloudy than the inland ones. (5) Rainfall is smallest in April, and, as a rule, greatest in November, and it increases from east to west.—The mean temperature of the air on each day of the year at the Royal Observatory, Greenwich, on the average of the fifty years 1841 to 1890, by Mr. W. Ellis. The values given in this paper are derived from eye observations from 1841 to 1848, and from the photographic records from 1849 to 1890. The mean annual temperature is 49°·5. The lowest winter temperature, 37°·2, occurs on January 12, and the highest summer temperature, 63°·8, on July 15. The average temperature of the year is reached in spring, on May 2, and in autumn on October 18. The interval during which the temperature is above the average is 169 days, the interval during which it is below the average being 196 days.

SYDNEY.

Royal Society of New South Wales, May 4.—Annual Meeting.—H. C. Russell, F.R.S., President, in the chair.—The report stated that 61 new members had been elected during the year, and the total number on the roll on April 30 was 478. During the year the Society held eight meetings, at which the following papers were read:—Presidential address, by Dr. A. Leibius.—Notes on the large death-rate among Australian sheep in country infected with Cumberland disease or splenic fever, and Notes on a spontaneous disease among Australian rabbits, by Adrien Loir.—Compressed-air flying machines, Nos. 13 and 14, and on a wave-propelled vessel, by L. Hargrave.—A cyclonic storm or tornado in the Gwydir district; Preparations now being made in Sydney Observatory for the photographic chart of the heavens; Notes on some celestial photographs recently taken at Sydney Observatory; and Notes on the rate of growth of some Australian trees, by H. C. Russell, F.R.S.—Some folk-songs and myths from Samoa, translated by the Rev. G. Pratt, with introductions and notes, by Dr. John Fraser.—Notes on the use, construction, and cost of service reservoirs, by C. W. Darley.—On the constitution of the sugar series, by W. M. Hamlet.—On kaolinite from the Hawkesbury Sandstone, by H. G. Smith.—A contribution to the microscopic structure of some Australian rocks, by the Rev. J. Milne Curran.—On some New South Wales and other minerals (note No. 6), by Prof. Liversidge, F.R.S.—Artesian water in New South Wales (preliminary notes), by Prof. T. W. E. David.——The Medical Section held four meetings. The following papers were read :—A brief account of the histology and development of tubercle, by Prof. Anderson Stuart.—Remarks upon the nature and treatment of diphtheria, by Dr. W. Camac Wilkinson.—Glimpses of the past : a series of sketches with pen and pencil of the medical history of Sydney, by Dr. Honison.——The Microscopical Section held five meetings. The following paper was read :—Notes on slicing rocks for microscopical study, by the Rev. J. Milne Curran.——The Civil and Mechanical Engineering Section held eight meetings. The following papers were read :—Recent researches on the strength, elasticity, and endurance of materials of construction with especial reference to iron and steel, by Prof. Warren.—The bridge over Lane Cove River at the head of navigation, by H. H. Dare.—On the calculation of stresses by means of graphic analysis, by J. I. Haycroft.—On the tacheometer and its application to engineering surveys, by W. Poole, Jun.—On the sewerage of country towns : the separate system, by Dr. Ashburton Thompson.——The Clarke Medal for 1892 had been awarded to Prof. W. T. Thiselton Dyer, F.R.S. The Council had issued the following list of subjects with the offer of the Society's bronze medal, and a prize of £25 for each of the best researches if of sufficient merit :—(To be sent in not later than May 1, 1893) Upon the weapons, utensils, and manufactures of the aborigines of Australia and Tasmania ; on the effect of the Australian climate upon the physical development of the Australian-born population ; on the injuries occasioned by insect pests upon introduced trees. (To be sent in not later than May 1, 1894) On the timbers of New South Wales, with special reference to their fitness for use in construction, manufactures, and other similar purposes ; on the raised sea-beaches and kitchen middens on the coast of New South Wales ; on the aboriginal rock-carvings and paintings in New South Wales.—The Chairman read the Presidential address, and the Officers and Council were elected for the ensuing year, Prof. Warren being President.

Paris.

Academy of Sciences, June 13.—M. d'Abbadie in the chair.—A new contribution to the history of the truffle, *Tirmania Cambonii*, "Terfâs" of Southern Algeria, by M. A. Chatin.—On subcutaneous or intra-venous injections of liquid extracts from several organs as a therapeutic method, by MM. Brown-Séquard and d'Arsonval.—In the place of the late Dom Pedro d'Alcantara, M. von Helmholtz was elected Foreign Associate.—Researches on the solar atmosphere, by Mr. George E. Hale, of the Kenwood Astrophysical Observatory, Chicago. A photograph of a metallic protuberance, obtained with an aperture of 12 inches and a large grating spectroscope, shows all the lines previously announced in the ultra-violet, and the following additional ones: 3961·7 (manganese?), 3900·7 (calcium), 3886·4 (hydrogen), and 3860·4 (iron?). The writer has succeeded in photographing faculæ in the centre of the disk.—On the general problem of the deformation of surfaces, by M. L. Raffy.—On the theory of the fuchsian functions, by M. Ludwig Schlesinger.—On transformations in mechanics, by M. P. Painlevé.—On considerations of homogeneity in physics, by M. A. Vaschy.—On the non-realization of the spheroidal state in steam boilers : reclamation of priority, by M. de Swarte.—On the co-existence of dielectric power and electrolytic conductivity, by M. E. Bouty. A rigid condenser is formed of iron disks separated by small wedges of mica, and joined by iron screws isolated by mica and placed opposite the wedges. This condenser is plunged into a fused mixture of equal parts of the nitrates of sodium and potassium. Air bubbles are carefully removed with plates of mica, and the condenser is withdrawn at the moment when the salt commences to solidify. The liquid, retained by capillarity, forms between the disks an adherent regular solid layer. The apparatus while yet hot is plunged into melted paraffin, which surrounds it with an isolating layer devoid of hygroscopic power. The experiments give a value for k approaching 4, and nearly constant within the limits of temperature in which the specific resistance in ohms may vary from $3·6 \times 10^{11}$ to $2·6 \times 10^{9}$, *i.e.* in the ratio of about 138 to 1. Here the conductivity and the dielectric capacity belong to molecules of the same kind. It is probable that, if the experiments could be extended to ordinary electrolytes, they would give results of the same kind—that is, finite values of the dielectric constant k. The distinction between dielectrics and electrolytes would thus solely reside in the amount of their conductivity. Dielectric polarization, established in a very short time in comparison with the ten-thousandth of a second, would correspond, in Grotthuss's scheme, to the initial orientation of the compound molecules, their conductivity to their progressive rupture.—On the retardation in the perception of the different rays of the spectrum, by M. Aug. Charpentier. On suddenly illuminating the slit of a spectroscope by white light, the red portion of the spectrum is seen first, and the light seems to shoot across from the red to the violet. This was confirmed by rotating an inverted sector of a circle, 1 cm. broad at the base, and 8 to 10 cm. long once in two or three seconds. The extreme point seemed drawn out into a kind of spectrum extending from the red to the green. The maximum duration of excitation compatible with the isolation of the colours does not exceed about four or five thousandths of a second.—On the anhydrous crystallized fluorides of nickel and cobalt, by M. C. Poulenc.—Action of nitric oxide upon the metals, and upon the metallic oxides, by MM. Paul Sabatier and J. B. Senderens.—Thermochemical study of guanidine, of its salts and of nitroguanidine, by M. C. Matignon.—Researches on the disodic derivatives of the three isomeric diphenols, by M. de Forcrand.—On normal pyrotartaric or glutaric acid, by M. G. Massol.—Study of the decomposition of the diazo compounds, by MM. J. Hausser and P. Th. Muller.—The folds in the Secondary formations in the neighbourhood of Poitiers, by M. Jules Welsch.—On the genesis of the ophiolitic rocks, by M. L. Mazzuoli.—Three cases of increase in the velocity of transmission of sense-impressions, under the influence of injections of the testicular liquid, by M. Grigorescu.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Country Thoughts for Town Readers: K. B. B. de la Bere (Simpkin).—The Etiology and Pathology of Grouse Disease : Dr. E. Klein (Macmillan).—Marine Shells of South Africa : G. B. Sowerby (Sowerby).—Atlas of Clinical Medicine. vol i. : Dr. B. Bramwell (Edinburgh, Constable).—The Standard Course of Elementary Chemistry, Parts 1–5: E. J. Cox (Arnold).—English Botany, Supplement to the Third Edition, Part 2 : N. E. Brown (Bell).—Volcanoes, Past and Present : Dr. E. Hull (Scott).—Den Norske Nordhaus-Expedition, 1876–78, xxi. Zoologi, Crinoida : D. C. Danielssen (Christiania, Grondahl).—Coal Gas as a Fuel, fourth edition : T. Fletcher (Liverpool, Tinling).

Pamphlets.—Twenty-second Annual Report of the Wellington College Natural Science Society, 1891 (Wellington College).—Johns Hopkins University of Baltimore Register for 1891–92 (Baltimore).—British Universities (Manchester, Cornish).

Serials.—Astronomy and Astro-Physics, June (Northfield, Minnesota).—L'Anthropologie, tome iii. No. 2 (Paris, Masson).—Journal of the Royal Microscopical Society, June (Williams and Norgate).—Contributions from the U.S. National Herbarium, vol. ii., No. 2 (Washington).—Bulletin of the New York Mathematical Society, vol. i. No. 9 (New York).

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THURSDAY, JUNE 30, 1892.

THE LONDON UNIVERSITY OF THE FUTURE.

AMONG the many points discussed in relation to the schemes for providing London with a University which have been under consideration during the last few years, scarcely any reference has been made to the higher teaching which ought to be at the disposal of the citizens of the most important and largest city in the world. Attention has been almost exclusively directed to the class teaching necessary to pass certain examinations which open the door to professional employment.

It is not necessary to enlarge upon this remarkable omission, although the reason for it is not far to seek, but we think it may be desirable, in order to show that such teaching is not Utopian, and that other nations freely provide what is so conspicuous by its absence in London, to give an indication of the quantity and quality of the teaching in the metropolis nearest our own.

The indications, to be exhaustive, would occupy several pages of NATURE, we must perforce content ourselves by giving the courses open to the citizens of Paris at the Sorbonne and the Collège de France.

The question does not concern science alone. We have not, therefore, limited ourselves to the scientific subjects; and it will be understood that, besides the undergraduate and graduate courses, there are special courses connected with the many other institutions in Paris allied either with the various professions directly, or with the national culture generally.

Among the former we may content ourselves at present with referring to the École Normal and the École Polytechnique; among the latter are the Museums of Natural History, of Physical Science, of Antiquities, Art and Archæology, each of these with lectures on the subjects which are illustrated by their contents.

We shall, if possible, take a subsequent opportunity of giving lists of these special courses, but the lectures at the University and College alone exhaust our space for this week. Comment on the breadth of the teaching and of the men to whom it is confided in Paris, and on the absence of anything approaching it here, is needless.

SORBONNE: FACULTY OF SCIENCES.

1892—*Second Scholastic Term.*

Day	Hour	Subject	Professor
MONDAYS.	8.30	Differential and Integral Calculus: Ordinary Differential Equations and Equations with Derived Partials	Picard.
	8.45	Lectures on Geology: General ...	Vélain.
	9	Lectures on Chemistry: Manipulations for the Licentiate ...	Riban.
	10	Lectures in Natural Science ...	Chatin.
	10.30	Calculus of Probabilities: Mathematical Theory of Hydrodynamic Vortices and Application to Electrodynamics	Poincaré.
	11	Lectures on Chemistry: Theoretical and Practical Qualitative Analysis	Riban.
	1.30	Lectures on Physical Sciences: Thermodynamics	Pellat.
	2.45	Mineralogy and Crystallography: Principal Mineral Species ...	Hautefeuille.
	3	Lectures on Mathematical Sciences	Puiseux.
	5	Lectures on Chemistry	Joly.
TUESDAYS.	8.30	Astronomy: Programme for the Licentiate's Degree	Wolf.
	8.30	Lectures on Natural Sciences: Botany	Vesque.
	8.30	Lectures on Mineralogy	Jannettaz.
	9	Lectures on Natural Sciences: Identification of Rocks, &c. ...	Vélain.
	10	Mechanics and Experimental Physics: Properties of Elastic Solids, &c.	Boussinesq.
	10	Histology: General Character of Elementary Anatomy; Nervous and Muscular Tissue from an Histological Point of View: Zoology	Chatin.
	10.30	Lectures on Chemistry	Joly.
	2	Physics: Electricity	Lippmann.
	2	Lectures on Mathematical Sciences: Differential and Integral Calculus	Kaffy.
	3	Do. do. do. do.	Kaffy.
	3.30	Zoology, Anatomy, Physiology: Zoophites, &c.	Delage.
	3.30	Course on Spectroscopy and Photographic Chemistry	Salet.
WEDNESDAYS.	8.30	Mechanics. Dynamics of Systems	Appell.
	8.45	Lectures on General Geology ...	Velain.
	9	Lectures on Chemistry: Manipulations for the Licentiate ...	Riban.
	10.15	Higher Algebra: Theory of Euler's Integrals and Functions of a Variable	Hermite.
	1.30	Organic Chemistry: Compounds of the Aromatic Series	Friedel.
	2	Lectures on Mathematical Sciences	Blutel.
	3	Geology: Principal Characters of Geological Periods; Geological Formations	Munier-Chalma
	3	Lectures on Mechanics and Astronomy	Puiseux.
	3.45	Analytical Chemistry: Determination and Separation of Metals...	Riban.
	4	Lectures on Physical Sciences: Questions on the Subjects of Prof. Lippmann's Cours ...	Foussereau.
THURSDAYS.	8.30	Lectures on Physical Sciences. Thermodynamics	Pellat.
	8.30	Differential and Integral Calculus, &c.	Picard.
	9	Lectures on Natural Science: Identification of Rocks and the Principal Characteristic Fossils	Velain.
	9	Lectures on Chemistry: Manipulations for the Licentiate ...	Riban.
	10	Lectures on Natural Science ...	Chatin.
	10.30	Calculus of Probabilities and Mathematical Physics: Theory of Vortices. Hydrodynamics: Application to Electrodynamics	Poincaré.
	1	Chemistry Lectures and Manipulations for Professors of Colleges	Riban.
	1.30	Lectures on Physical Sciences: Reflection and Refraction of Light	Foussereau.
	1.30	Lectures on Mathematical Sciences as a Whole	Kœnigs.
	2.30	Do. do. do. do.	Kœnigs.
	2.45	Mineralogy and Crystallography, &c.	Hautefeuille.
	4	Lectures on Physical Sciences ...	Pellat.
	5	Lectures on Chemical Sciences ...	Joly.

Day	Hour	Subject	Professor
FRIDAYS.	8.30	Lectures on Physics	Pellat.
	8.30	Mechanics: Dynamics of Systems	Appell.
	8.30	Lectures on Botany	Vesque.
	9	Lectures on Chemistry and Manipulations for the Licentiate	Riban.
	9	Lectures on Geology: Identification of Rocks and the Principal Characteristic Fossils	Velain.
	10	Mechanical and Experimental Physics, &c.	Boussinesq.
	10.30	Organic Chemistry: Compounds of the Aromatic Series	Friedel.
	1	Lectures on Chemistry and Manipulations	Riban.
	3	Lectures on Mathematical Sciences: Differential Calculus	Kaffy.
	3	Geology: Geological Periods; Secondary Formations	Munier-Chalma.
	4	Lectures on Physical Sciences: Subjects of Prof. Lippmann's Course	Foussereau.
	5.30	Lectures in Mathematical Sciences	Kaffy.
SATURDAYS.	8.30	Astronomy: Programme for the Licentiate	Wolf.
	8.30	Lectures on Mineralogy	Jannettaz.
	10.15	Higher Algebra: Euler's Integrals, &c.	Hermite.
	10.30	Lectures on Chemistry	Joly.
	2	Physics: Electricity	Lippmann.
	3	Lectures on Mathematical Sciences: Mechanics and Astronomy	Puiseux.
	3.30	Zoology, Anatomy, Comparative Physiology	Delage.
	3.30	Lectures on Organic Chemistry	Salet.

FACULTY OF LETTERS. 1892—*Second Term.*

Day	Hour	Subject	Professor
MONDAYS.	9.30	Lectures on French Literature	Gazier.
	11	Complementary Course in English Language and Literature	Beljame.
	1.15	Pedagogy Lectures (Historical Sciences), General Contemporaneous History	Seignobos.
	1.30	History of Ancient Philosophy: Moral and Political Doctrines of Aristotle	Waddington.
	1.30	Lectures on French Literature	Gazier.
	1.30	Lectures on German Language and Literature: History of the German Language	Lange.
	1.30	Lectures on Latin Language and Literature	Lafaye.
	2	History Lectures: General History of the Seventeenth and Eighteenth Centuries	Zeller.
	2.30	French Literature of the Middle Ages: History of the French Language: History of Literature in France in the Fourteenth Century. Froissart	Julleville.
	3	Latin Language and Literature	Lafaye.
	3	Greek Eloquence: Greek Moralist Writers	Croiset.
	3	Foreign Literature: Æsthetic and Moral Literature of Goethe; General Character of Faust	Lichtenberger.
	3	Modern History: History of Legislation from the Sixteenth to the Eighteenth Centuries	Lemonnier.
	3.30	Literature of Southern Europe: Cervantes's Works	Gebhart.
	4	History of Philosophy: Modern Texts	Boutroux.
	4	Modern History: Practical Exercises	Lemonnier.
	4.15	Modern and Contemporaneous History: History of Russia in the Sixteenth Century	Rambaud.
	5	History of Modern Philosophy: Texts	Boutroux.

Day	Hour	Subject	Professor
TUESDAYS.	9	French Literature: Practical Exercises	Larroumet.
	8.45	Ancient History: Commentary on a Text	Bouché Leclercq.
	9	Sanskrit, and Comparative Grammar of the Indo-European Languages, &c.	Henry.
	9.45	Ancient History; Greek and Roman Institutions	Bouché Leclercq.
	10	History of Ancient Philosophy	Waddington.
	10-11	Latin Poetry: Practical Exercises	Cartault.
	10.15	French Poetry; Explanation of one of the Authors from the Licentiate and Fellowship Programme	Lenient.
	10.30	History: Practical Exercises	Zeller.
	1.30	Discourses on Contemporaneous Philosophy	Janet.
	1.45	Ancient History: History of the Roman Empire from the Time of Nero	Guiraud.
	2	Letters of Southern Europe: Dante	Gebhart.
	2	Greek Language and Literature	Hauvette.
	3	Geography: History of the Exploration of America since Columbus, &c.	Himly.
	3	French Literature: Practical Excises	Larroumet.
	3.15	Latin Language and Literature: History of Latin Literature	Lafaye.
	4.15	Greek Language and Literature	Hauvette.
	4.45	History of Philosophy: Systems of Spinoza and Malebranche	Brochard.
WEDNESDAYS.	9	French Eloquence	Crouslé.
	9.15	Pedagogy (Historical Sciences)	Seignobos.
	9.30	Sanskrit: Relations of India with the West	Levi.
	10	Archæology: History of Vase-painting in Greece	Collignon.
	10.30	Philosophy	Janet.
	11	Archæology: Practical Exercises in Archæology	Collignon.
	1	Latin Eloquence: on Roman Eloquence under the Republic	Martha.
	1.30	Ancient History	Guiraud.
	1.30	French Literature: French Literature in the Seventeenth Century	Gazier.
	1.30	Mental Philosophy	Seailles.
	2.15	History of French Colonization and Beginning of the French Restoration	Pigeonneau.
	2.30	Ancient History: Practical Exercises	Guiraud.
	2.30	Philosophy	Seailles.
	2.45	Philology and Metre: Written and Oral Exercises on Metre	Havet.
	3.30	History of the French Revolution: History of the National Constitution	Aulard.
	3.30	Sanskrit, and Comparative Grammar of the Indo-European Languages	Henry.
	4	History: Practical Exercises	Pigeonneau
	4	Greek Poetry: Lyric Element of Greek Tragedy	Decharme
	4.45	History of Modern Philosophy: Idea of Natural Law, &c.	Boutroux.
	5	Sanskrit, and Comparative Grammar of the Indo-European Languages	Henry.
	5	English Language and Literature	Baret.

Day	Hour	Subject	Professor
Thursdays.	8.30	History of the French Revolution: Exercises	Aulard.
	9	Greek Literature and Institutions: Correction of Greek Themes, &c.	Girard.
	9.30	History of the French Revolution: Explanation of Titles	Aulard.
	9.30	Lectures on the History of Philosophy: Practical Exercises	Brochard.
	10	Latin Poetry: Passages from Lucretius	Cartault.
	10	Lectures on English Language and Literature: Practical Exercises	Baret.
	10.15	Lectures on Greek Literature and History: Explanation of the Authors in the Programme	Girard.
	10.30	Lectures on the History of Philosophy	Brochard.
	10.45	History Lectures: Bassoinpierre's Memoirs	Zeller.
	1	English Language and Literature: Shakespeare—French Literature	Beljame.
	1.30	Lectures on German Language and Literature: Correction of Themes and Dissertations	Lange.
	2	French Poetry: Patriotic Poetry in France since the 16th Century	Lenient.
	2	English Language and Literature: Othello	Beljame.
	2	Roman Philology: First Chapters of Dante's Inferno	Thomas.
	3	Foreign Literature: Preparation for the Examination in German	Lichtenberger.
	3	Modern History: Relation of French Art to Institutions, &c.	Lemonnier.
	3.30	French Literature of the Middle Ages	Julleville.
	4	Foreign Literature: Preparation for the Examination in German	Lichtenberger.
	4.15	Geography: History of the Exploration of America since Columbus	Himly.
Fridays.	9	Course of Roman Philology: Explanation of Texts with French, &c.	Thomas.
	9	Complementary Course: Auxiliary Sciences—on the History of Latin Literature	Langlois.
	9.15	Latin Eloquence: Explanation of Latin Authors	Martha.
	9.30	Complementary Course in Sanskrit: Explanation of Elementary Texts	S. Levi.
	10	Complementary Course in Philology and Metre: on Metre	Havet.
	10	Complementary Course of Roman Philology: History of the Literature	Thomas.
	10.15	Lectures on Pedagogy: Theory of History Teaching	Seignobos.
	1	Lectures on Greek Language and Literature: History of Greek Literature	Hauvette.
	2.30	Greek Poetry: Explanation of Texts, and Practical Exercises	Decharme.
	2.30	History of the Middle Ages: on French Ecclesiastical Institutions	Luchaire.
	3.30	Practical Exercises in History	Luchaire.
	3 30	Ancient History: History of Rome from Scylla to Cæsar	BouchéLeclercq
	3.30	Greek Poetry: Explanation of Texts, and Practical Exercises	Decharme.
	4	Modern and Contemporaneous History: History of the Hindus under Queen Victoria	Rambaud.
	4.15	French Literature (Complementary Course): History of French Literature in the 18th Century	Larroumet.
	4.45	Lectures on Geography: Text of the Programme	Dubois.
Saturdays.	9	Greek Eloquence: Explanation of Greek Texts and Letters, &c.	Croiset.
	9	Complementary Course: Auxiliary Sciences—on the History of Palæography	Langlois.
	10	Complementary Course in Literature: on the Archæology of the Middle Ages	Langlois.
	10.15	French Eloquence: French Writers of Prose in the Nineteenth Century	Croiset.
	10.15	Lectures on Greek Literature and History: History of Greek Poetry since the Fifth Century	Girard.
	1.30	Greek Eloquence: Practical Exercises	Crouslé.
	1.30	Lectures on German Language and Literature	Lange.
	1.30	Lectures on Philosophy	Seailles.
	2	Lectures on Geography: Various Questions in General Geography	Dubois.
	3	Latin Poetry: Lucretius and Latin Poetry during the Ciceronian Epoch	Cartault.
	3	Archæology: Sculpture in Greece to the Fifth Century	Collignon.
	3	Lectures on Geography: Practical Exercises	Dubois.
	4	History: History of the Doctrine of Economics during the first part of the Nineteenth Century	Pigeonneau.

Collège de France.

1892—*Second Term.*

Day	Hour	Subject	Professor
Mondays.	9	Modern Philosophy: concerning the Soul	Nourrisson.
	9	Natural History of Inorganic Bodies	Fouqué.
	10	Language and Literature of the Arabs: Moallakat and Divans of Six Poets	B. de Meynard.
	10.15	Æsthetics and History of Art: History of Italian Art under Pius II.	Lafenestre.
	10.15	Celtic Languages and Literature: Ancient and Middle Irish Texts	H. d'Arbois de Jubainville.
	10.30	Organic Chemistry: on Organic Synthesis and Hydrocarbons	Berthelot.
	11.15	Comparative Grammar: Theory of the Verb in Indo-European Languages	Bréal.
	12.30	Egyptian Philology and Archæology: Pyramid Texts	Maspero.
	1.30	History of Latin Literature: History of the Latin Theatre	Boissier.
	2.30	Greek Epigraphy and Antiquities: Athenian Constitution of Aristotle	Foucart.
	3	History of Religion: History of Judaism during the last Four Centuries of the Christian Era	Réville.
	3.15	Experimental and Comparative Psychology: Will, Heredity, Perception	Ribot.
	3.30	Semitic Epigraphy and Antiquities, with Epigraphic Texts	Clermont-Ganneau.
	4.45	Latin Philology: on the Prosody of Vowels in the Latin Language	Havet.

Day	Hour	Subject	Professor
Tuesdays.	9	History of Latin Literature	Boissier.
	10	Assyrian Philology and Archæology: Deciphering of the Assyrian Characters	Oppert.
	10.30	General and Experimental Physics: on the Optics of the Atmosphere	Mascart.
	1	Greek and Latin Philosophy: Epicurean Doctrine	Lévêque.
	1	Languages and Literatures of Slavonic Origin	Leger.
	1	Analytical and Celestial Mechanics: Applications, &c.	Kœnigs.
	1.30	General History of Science: Advent of Grecian Geometry: Abstract Science	P. Lafitte.
	2	History of Comparative Legislation: Political Writings of J. de Maistre	J. Flach.
	2	Geography: Economic Statistics and History: on French Colonization	Levasseur.
	3	Robert Browning's Poems	Guizot.
	3.15	Political Economy: John Stuart Mill: Principles of Political Economy	Leroy-Beaulieu.
Wednesdays.	10	French Language and Literature of the Middle Age: Life of St. Alexis	G. Paris.
	11.15	Language and Literature of Southern Europe	Meyer.
	12.30	Grecian Language and Literature: Sophocles	Rossignol.
	12.30	Egyptian Philology and Archæology: History of Egyptian Feudalism	Maspero.
	1	General Physics and Mathematics: Mechanical Properties of Electric Currents	Deprez.
	1.30	Mineralogical Chemistry: Chemical Analysis and History of the Metals	Schützenberger.
	2	Hebrew Language and Literature: Chaldean and Syrian Languages and Literatures	E. Renan.
	2	Comparative Embryology: Physiological *rôle* of the Cellular Nucleus	Balbiani.
	2	Modern French Language and Literature: French Romantic School	Deschanel.
	3	Sanscrit Language and Literature: Extracts from Mahâbhârata	Foucaux.
	3.30	Semitic Epigraphy and Antiquities: Hebrew Inscriptions of Jerusalem	Clermont-Ganneau.
	3.30	Natural History of Organic Bodies	F. Franck.
	4.30	Medicine: on the Muscle, and Animal Thermodynamics	D'Arsonval.
	5	General Anatomy: on the Vascular System	Ranvier.
Thursdays.	9	History and Morals	Longnon.
	9	Natural History of Inorganic Bodies: Work of Richthofen on the Geology of China	Fouqué.
	10	Assyrian Philology and Archæology	Oppert.
	10.15	Æsthetics and History of Art: History of Italian Art under Peter II.	Lafenestre.
	11.30	Language and Literature of Southern Europe: Roman de Jaufré	Meyer.
	12.45	Mathematics: Principles of the Infinitesimal Calculus	Jordan.
	1	Roman Epigraphy and Antiquities	Cagnat.
Thursdays (*cont.*)	2.15	Russian History from Catherine II. to Alexander I.	Leger.
	3	Chinese Language and Literature: Tartar and Manchu Language and Literature	[Denis. D'Hervey de St.
	3	History of Religion: History of Judaism during the last Four Centuries	Réville.
	3.15	Experimental and Comparative Physiology	Ribot.
Fridays.	10	Arabic Language and Literature:	Barbier de Meynard.
	10.15	Celtic Language and Literature	H. d'Arbois de Jubainville.
	10.30	Organic Chemistry: Hydrocarbons in particular	Berthelot.
	11.15	Comparative Grammar: Theory of the Verb in Indo-European Languages	Bréal.
	12.30	Greek Language and Literature: Sophocles	Rossignol.
	12.30	Works of Robert Browning	Guizot.
	1	Greek and Latin Philosophy: Doctrines of Epicurus	Lévêque.
	1	Analytical and Celestial Mechanics, Geometrical and Mechanical Applications	Kœnigs.
	12.45	Roman Epigraphy and Antiquities: French and Foreign Inscriptions	Cagnat.
	1.45	Greek Epigraphy and Antiquities: Mysteries of Eleusis	Foucart.
	2	History of Comparative Legislation: Landed Property in England and France since the Eighteenth Century	Flach.
	2	Persian Language and Literature: Relation between the Pehlvi and Persian	Darmesteter.
	2	Geography: Economic History and Statistics (Algeria, Colonies)	Levasseur.
	3.15	Political Economy: on Public Revenues and Imports	Leroy-Beaulieu.
	3.30	Natural History of Organic Bodies	Franck.
	4.30	Medicine: Animal Muscle and Thermodynamics	D'Arsonval.
	5	General Anatomy: on the Vascular System	Ranvier.
Saturdays.	9	Modern Philosophy: Spinoza	Nourrisson.
	10	French Language and Literature of the Middle Ages: Life of St. Alexis	G. Paris.
	10.30	Experimental and General Physics: Optics of the Atmosphere	Mascart.
	12.45	Mathematics: Principles of the Infinitesimal Calculus	Jordan.
	1	Mathematics and General Physics: Electric Currents	Marcel Deprez.
	1	French Language and Literature: Principal Writers	Deschanel.
	1.30	Mineralogical Chemistry: Analytical Chemistry and History of the Metals	Schützenberger.
	2	Persian Language and Literature: Relation between the Pehlvi and Persian	Darmesteter.
	2	Comparative Embryology	Balbiani.
	2	General History of the Sciences	P. Lafitte.
	3	Chinese Language and Literature: Tartar and Manchu Language and Literature	[Denis. D'Hervey de St.
	2.30	Hebrew, Chaldean, and Syrian Languages and Literatures	E. Renan.
	3	Sanskrit Language and Literature: Lalila Vistara (Life of Buddha)	Foucaux.
	4.45	Latin Philology: Palæography of the Latin Classics	Havet.

ENGLISH BOTANY.

English Botany. Supplement to the Third Edition. Part I. (Orders I.–XXII.). Compiled and Illustrated by N. E. Brown, of the Royal Herbarium, Kew. Pp. 56, viii., 6 Plates. (London: Bell and Sons, 1891 [1892].)

THE third edition of "English Botany" was begun just thirty years since by Dr. Boswell (then Syme), and continued at somewhat uncertain intervals, the flowering plants being completed in 1872. The ferns followed at a later period, and the volume containing them was completed by Mr. N. E. Brown, owing to the failure of Dr. Boswell's health.

Although styled a third edition, Dr. Boswell's work was, as everyone knows, a thoroughly new book. It was the production of one who knew plants in the field as well as in the herbarium, and who had a firm hold of his subject. Mr. J. G. Baker, who speaks with authority in matters of this kind, says:—

> "It is not alone the fulness and accuracy of the descriptions that make the book so valuable, but the power he shows in grasping the relationship of the types, and the acute sense of proportion shown in their arrangement. . . . I never cease, when I use the book, to admire the skill which is shown in dividing out the types into species, sub-species, and varieties—a task that was done so thoroughly well that when Sir J. D. Hooker, with all his wide experience, went over the same ground shortly after, in his 'Student's Flora,' he found extremely little to change."[1]

The book, indeed, had defects, among which may be mentioned the "popular portion" and the bad colouring of the plates, but for these Dr. Boswell was not responsible: and although the history of our British flora may seem to some to have received less attention than it merited, the author's work well deserves the high praise which Mr. Baker bestowed upon it.

The first part of the "Supplement," now before us, is the work of Mr. N. E. Brown. Mr. Brown has long been recognized as an authority upon certain difficult groups of plants. He has probably a greater knowledge of the *Stapelieæ*, for instance, than any man living; he has done much good work among the *Aroideæ;* and his many years' employment in the Kew Herbarium has been productive of other valuable contributions to systematic botany. He is careful and painstaking, and a fair draughtsman. Yet with all these qualifications he is not the man to whom the "Supplement to English Botany" should have been entrusted. Such a task could only be carried out satisfactorily by one whose knowledge of British plants was based upon an acquaintance with them in the field as well as in the herbarium, and Mr. Brown's name does not occur to us in this connection.

There was, as it seems to us, one way, and only one, in which a "Supplement to English Botany" could have been done satisfactorily. During the last thirty years our flora has received many additions of *bonâ fide* types; these should, of course, have been figured and described. Having regard to the execution of the third edition, the novelties in certain critical genera—such as *Rubus* and *Hieracium*—might have found a place; although the correlation of English with continental forms which is still proceeding in the former genus, and the (too slow) publication of Mr. F. J. Hanbury's monograph in the latter, would have justified their partial if not entire exclusion. But the attempt to put into the old bottles the new wine of recent research could only result, as it has resulted, in failure. The Batrachian Ranunculi, for instance, may not have been treated satisfactorily by Dr. Boswell; and Mr. Brown perhaps does well to reproduce a subsequent note by that author modifying his views. But the treatment as it stood was a consistent piece of work—the expression of the opinion of one man. Mr. Brown endeavours to fit Mr. Hiern's well-known paper on these plants into Dr. Boswell's original descriptions—a Procrustean undertaking, and one which, in our judgment, is entirely valueless, representing as it does neither Dr. Boswell's, Mr. Hiern's, nor any other consistent view about these troublesome plants. Mr. Brown's style is so terribly involved that it is often very difficult to ascertain what he means; and he would have been far wiser had he left the Batrachian buttercups alone.

For his rearrangement of *Thalictrum* he made "a careful examination of all the material at [his] disposal." It will hardly be believed that neither in this nor in any other instance has he taken the trouble to consult Dr. Boswell's own herbarium, although this, as Mr. Brown must know, is readily accessible to all London botanists. The craze—we can use no milder term—for burdening our lists with varietal names on the most trivial pretexts receives Mr. Brown's support: he resuscitates Pritzel's names for the bluish and reddish-flowered forms of *Anemone nemorosa* (identifying the former with the *A. Robinsoniana* of gardens), although he adds that they are "mere colour forms," with "numerous intermediate shades." Mr. Melvill's name is attached to a "var. *rosea*" of *Silene gallica*, although he did not rank it as such, but referred to it as a "form merging by every gradation into" *quinquevulnera;* and Mr. Brown enriches our nomenclature with a new name—"*Silene anglica* var. *maculata*, N.E. Br."

Speaking of Mr. Pryor's var. *oleracea* of *Silene Cucubalus*, Mr. Brown says:—

> "If the plant intended is the same as *S. inflata* var. *oleracea*, Ficinus, 'Flora der Gegend um Dresden,' ed. 2, vol. i. p. 313 (1821), which is figured in Reichenbach, Icones Fl. Germ. et Helvet., vol. vi. pl. 300, f. 5120 γ, it is," &c.

Now, Mr. Pryor appends to his varietal name a reference to "Bor. Fl. Centr., ed. iii., ii., 95," and Boreau cites Reichenbach's t. 300 for his plant. How, then, can there be any question as to the plant "intended"? If Mr. Brown means to say that he is doubtful as to the accuracy of Mr. Pryor's identification, that is, of course, another matter.

Prof. L. H. Bailey lately spoke with deserved severity of certain "authors of local floras" as obtaining "a cheap notoriety by making new combinations" in nomenclature; and no one can glance through this "Supplement," or refer to the pages wasted in discussing the nomenclature of *Corydalis* and *Spergularia*, without applying his remarks, to the compiler thereof.

Much space is also taken up, and in our opinion wasted by the relegation of species to other genera than those in which they were placed by Dr. Boswell. The following note on "*Lychnis alba*, Mill.," is an illustration of this, and will serve at the same time as an example of Mr. Brown's style:—

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[1] *Journal of Botany*, 1888, p. 83.

> "This is the *Silene pratensis* of vol. ii. p. 67, but, together with *S. diurna* of p. 69, should be referred to the genus *Lychnis*, where they properly belong; *S. diurna* being *Lychnis dioica*, Linn.; this name has been objected to on the ground that Linnæus included *L. alba* as a variety of *L. dioica*, which objection is untenable as it appears to me; still, if Linnæus's name is rejected, then *L. diœcia*, Miller ('Gardener's Dictionary,' ed. 8, No. 3, errata, 1768), must take precedence over *L. diurna*, Sibthorp ('Flora Oxoniensis,' p. 145, 1794)."

Here is another example:—

> "*Geranium striatum*, Linn. This plant was first published by Linnæus as *Geranium versicolor* in his 'Centuria I. Plantarum,' p. 21 (1755); but in 1759, when this same Centuria was republished in his 'Amœnitates Academicæ,' vol. iv., he altered the name to *G. striatum*, p. 282, which name was retained by Linnæus in all his later works, so that in all probability Linnæus regarded the name *G. versicolor* as a clerical error, which appears to me a consistent view to take of the case, the more so as it is also probable that the original Centurias were only printed for a restricted, or possibly private, distribution."

It is evident, in spite of all its defects, that Mr. Brown has lavished—we do not like to use a stronger expression—a great deal of time and trouble over this "Supplement." A less careful worker, indeed, might easily have produced a better book; for the trivial corrections and emendations, the questions of synonymy, the minute criticisms, and the unnecessary additions, would not have been put forward by any save the most conscientious of writers. There is an appendix of "additions and corrections," occupying an eighth of the whole, but, at any rate so far as "corrections" are concerned, far from exhaustive. And yet, with all this elaboration, the book is not as complete as it should be. The remarkable *Sagina* described in 1887 by Dr. F. Buchanan White as *S. Boydii* is not figured, and Mr. Brown has not even seen a specimen of the plant. Mr. Boyd has had it in cultivation for several years, and would, we doubt not, have supplied examples; and it is not easy to understand why Mr. Brown omitted to make himself acquainted with this very striking form. The plates are mostly poor: to one there is no reference in the letterpress; another is wrongly numbered.

Since the foregoing was written, the second part of the "Supplement" has appeared. It is mainly occupied with the Rose and Brambles, concerning which Mr. Brown says, "I express no opinion, as I have never made any attempt whatever to study them." This is commendably candid, but adds materially to the difficulty of understanding why Mr. Brown was selected for the work, while it deprives the compilation of value. JAMES BRITTEN.

A BACTERIOLOGICAL HAND-BOOK.

Bacteriologisches Practicum zur Einführung in die practischwichtigen bacteriologischen Untersuchungsmethoden für Aerzte, Apotheker, Studirende. By Dr. W. Migula. (Karlsruhe: Otto Nemnich, 1892.)

ALTHOUGH a knowledge of bacteriological methods is essential not only to those who seriously take up the study of bacteria, but also to many who, like the candidates for the diploma of public health, take but a compulsory glance at bacteriology, yet the supply of manuals describing the details of bacteriological practice is remarkably meagre.

Dr. Migula's little book should, therefore, prove very welcome to the bacteriological student, for it does not aspire to be an exhaustive work on bacteria in general, the list of which is receiving constant additions, but aims at describing simply and carefully in a handy form the principal methods of working with micro-organisms.

A number of varieties are more or less elaborately given, but the main idea has been to seek out characteristic forms which are intended to serve as types to illustrate the various points dealt with in the treatment of bacteria.

All the stages in the laboratory life-history of a micro-organism are elaborately entered into, and special chapters are devoted to the formation and staining of spores, and also to the nature of the flagella and most improved methods of exhibiting them in microscopic preparations. The latter are beautifully displayed in a photograph, showing the numerous flagella attached to the typhoid bacilli. The preparation of the various culture-media is described very minutely, and there are many useful laboratory hints and it is the more surprising, therefore, to find the method of sterilizing milk without altering its chemical composition omitted. This mode of preparing milk is naturally of importance in any inquiry as to the vitality of pathogenic micro-organisms in this medium. Again, the plan of cultivating bacteria on potatoes in tubes is not given, although it presents many decided advantages over the "dish method."

Dr. Migula repeatedly insists upon the necessity of unremitting care in carrying out all bacteriological operations to prevent the access of contamination either from the air or by contact with unsterilized or imperfectly sterilized objects. Such precautions are naturally of the utmost importance, but possibly it is unnecessary to warn students against contaminating their platinum needle through testing its temperature after heating by placing it to their lips. Such a proceeding, if ever attempted, would certainly not be quickly repeated!

But there is one piece of advice upon which the author lays great stress, and which in our opinion is not only unnecessary, but a constant menace to success. On almost every page, in one capacity or another, we find the use of corrosive sublimate most strongly recommended as a means of assisting sterilization and of affording additional protection from external contamination. It cannot be impressed strongly enough upon the student that he must depend for the success of his cultivations, not on the use of *antiseptics*, but by working on strictly *aseptic* principles, through the most conscientious devotion to every detail and precaution with which he is acquainted. The fear of contamination must ever appear to him as threatening as the "sword of Damocles," which will descend with unerring certainty as soon as the least evidence of relaxation is visible. Not only is the use of corrosive sublimate demoralizing, then, but on account of its very germicidal properties, unless handled with the utmost care, will prove a positive danger, destroying where it is least expected or wanted. This opinion is unfortunately the result of experience and not of mere imagination.

The examination of water is given *in extenso*, but there is no mention, when discussing the presence of typhoid bacilli in water, of the latest methods for their detection amongst other micro-organisms contained in natural waters.

The investigation of air for micro-organisms is entirely left out, an omission which renders the book less complete than it would otherwise appear to be.

But there is a great deal of instruction, together with many valuable hints, contained in the comparatively short space of 200 pages; and whilst, interspersed in the text, wood-cuts serve to supplement some of the descriptions of apparatus, it also boasts some very good photographs from original preparations of the *Staphylococcus pyogenes citreus*, the *Streptococcus erysipelatis*, the *Bacillus anthracis* with spores, the tuberculosis Bacillus, Koch's comma Spirillum, and others.

There is also appended a useful list of all the requisite appliances for bacteriological work.

GRACE C. FRANKLAND.

OUR BOOK SHELF.

Neue Rechnungsmethoden der Höheren Mathematik. Von Dr. Julius Bergbohm. (Stuttgart: Selbstverlag des Verfassers, 1892.)

Neue Integrationsmethoden auf Grund der Potenzial-, Logarithmal-, und Numeralrechnung. (The same.)

THE first of these pamphlets contains an account of what the author calls the *Immensalrechnung*, the *Potenzialrechnung*, the *Radikalrechnung*, the *Logarithmalrechnung*, and the *Numeralrechnung*. In the *Immensalrechnung* an attempt is made to provide a calculus of the infinitely great (*das Immensal*), which shall form a complement to the differential calculus, or calculus of the infinitely small. The *Potenzialrechnung* contains an account of exponential functions in which the base is an infinitely small or an infinitely great quantity, and the exponent is infinitely small; and the *Radikalrechnung* an account of the inverse functions that are obtained from these by changing the exponent into its reciprocal. So, too, in the *Logarithmalrechnung*, logarithmic functions are considered in which the base and the argument are either infinitely small or infinitely great; and in the *Numeralrechnung* the inverse functions (antilogarithms or exponential functions) are discussed. The pamphlet is occupied, for the most part, with an exposition of the author's notation, a discussion of certain indeterminate forms, and a calculation of some algebraic functions containing an infinitely small argument, to a first, second, or third approximation. It is hardly possible to compliment the author on his accuracy, seeing that the statement occurs that Lt. log x is finite when x is zero or infinity, the reason given being that Lt. ($x \log x$) and Lt. ($\log x/x$) are zero, for these values of x.

The second pamphlet begins with a *résumé* of some of the results of the first one; and then proceeds to discuss the application of these results to the evaluation of certain elementary integrals. The author's avowed object is to provide a method for the direct calculation of integrals, comparable with that now employed in differentiation, so that it may no longer be necessary to resort to the indirect methods of integration at present employed. It is impossible to deny that the object is a laudable one; but, to judge from the examples given in this pamphlet, it does not seem likely that the method will be of much use in the case of integrals of any degree of complexity. Dr. Bergbohm promises to supply us in the future with further examples of the application of his methods; but, until these have appeared, it is hardly possible to say that students of mathematics will find these pamphlets repay them for the trouble of reading them and of mastering the author's notation.

R. E. A.

An Elementary Course in Theory of Equations. By C. H. Chapman, Ph.D. (New York: John Wiley and Sons, 1892.)

THIS is really an excellent little book, but is rather misnamed in being called an elementary treatise. The study of the theory of equations, although generally expanded far too considerably, is here dealt with in rather the reverse way, the treatment being somewhat too curt. For anyone beginning this subject the book would be found slightly difficult, but for a student who has already had a little experience in this direction, it should prove a very useful *vade mecum*, for the author has brought together in a few pages just those portions of the subject that are required in actual practice. The three sections treat respectively of determinants, algebraical equations, and the methods by which the real roots of numerical equations are computed, and they are each accompanied by numerous examples.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

"The Grammar of Science."

IT is very idle as a rule to criticize a critic, especially when he happens, like C. G. K., to be the disciple of a school which the author of the criticized work is gently laughing at throughout his pages. But some of C. G. K.'s remarks might lead your readers to believe that the "Grammar of Science" is nonsense, even when looked at without the spectacles of the Edinburgh physical school, and his review may therefore justly call for a few words of reply.

Because C. G. K. found himself entirely unable to follow my argument as to the universality of scientific law, he was hardly justified in putting an antecedent before a consequent, and making nonsense of it. The universality of scientific law depends on the similarity of the perceptions and of the reflective faculties in normal civilized man. Why does this similarity exist? asks C. G. K.; and then turns for an answer to an antecedent in the argument—namely, that a condition of this universality is the similarity in those perceptions and reflective faculties. As a matter of fact in the "Grammar" itself, it is pointed out that a society of beings with different perceptions and reflective faculties could hardly survive in the struggle for existence with societies where there was an approach to similarity; that as soon as the divergence reaches a certain magnitude we lock up the individual as a madman or an idiot, or, in milder cases, bring great social pressure to bear upon him, and mould him to the ordinary standard.

"The laws of Nature are a mental product, yet a certain evolution theory logically based upon them quite eliminates the mental," writes C. G. K. of the "Grammar." Where he found this statement I know not, but what the "Grammar" itself states is: that the laws of evolution are themselves a mental product, a description in shorthand of the sense-impressions and stored sense-impresses of the mind at a given instant. They are a mental mode of briefly classifying sense-impressions, and not inherent in something behind sense-impressions themselves.

C. G. K. then quotes my statements as to Maxwell's descriptions of energy and matter. Now what the "Grammar" says is that Maxwell's statements are "extremely valuable as expressing concisely the nature of certain conceptual processes by aid of which we describe certain phases of our perceptual experience, but as defining matter they carry us no further than the statement that matter is that which moves," or indeed than Prof. Tait's statement that "matter is that which occupies space." The whole object of the investigation is to show that mass, but *not* matter, is capable of definition. As Clerk Maxwell tells us that his statements contain all we *know* of matter and energy, it is clear that these are the only statements by way of *definition* which he conceives it advisable to give of them, and *they are all he does give.* I happened to be one of the unfortunate Cambridge students whose first notions of matter and force were obtained from the "Treatise on the Dynamics of a Particle," and it was therefore a relief to me when I met with Kirchhoff's "Mechanik" in 1876, and found the subjectivity of force clearly insisted on. That view of force was in the air of Berlin when I was a student there in 1879. Kirchhoff's services in this matter are referred to with special emphasis on p. 139 of the "Grammar." A perfectly consistent view of force and matter had been published by Mach in 1883. Why the fact that Prof. Tait put forward the "subjectivity of force" in a work of 1885 makes me therefore "a disciple of Prof. Tait," I fail to understand. This statement is the more astonishing, as Prof. Tait directly postulates the "objectivity of matter," but in the same work tells us that "matter is, as it were, the plaything of force." How subjective force can have an objective plaything, perhaps C. G. K. will inform us; but the statement clearly marks off the standpoint of the "Grammar" from that of Prof. Tait. Mass, according to the "Grammar," can only be defined as the ratio of mutual accelerations, and any attempt to connect it with the "quantity of matter" in a body is asserted to be unphilosophical. C. G. K. asks if a passage he quotes from Tait's "Properties of Matter" is not *essentially* the theory of "ether-squirts"? I reply *No*, the words "*constantly* swallows up an amount proportional to its mass," or "at a rate proportional to its mass," sufficing to exclude the mutually enforced flows of ether on which the "Grammarian" bases his applications of ether-squirts to chemical and cohesive actions (*American Journal of Mathematics*, vol. xiii., pp. 309–62). Had I ever read, or if read, recollected, Sir William Thomson's suggestion, it would have been referred to, and a reference to him will be introduced into later editions of the "Grammar."

C. G. K. very skilfully tries to turn off the "Grammarian's" criticism of the Edinburgh school by representing it as an attack on Newton. The words in the "Grammar" are: "Remembering these points we will now turn *to the version of the Newtonian laws given by Thomson and Tait*" (p. 381). Force, say our writers, is any cause that tends to alter a body's natural state of rest, or of uniform motion in a straight line; but force, says Prof. Tait, is *subjective*, and corresponds to nothing which exists outside ourselves. Surely it is a "veritable metaphysical somersault" to then assert that it can be "applied in a straight line"? I fail completely to see how the view that force is subjective is consonant with the definitions and laws put forward by Thomson and Tait, and asserted by them to be Newtonian. With regard to Newton's own statements, I openly declare that, with all admiration for his genius, I doubt the logical sequence and accuracy of many of his statements with regard to the philosophical basis of dynamics. Those who would bind down all time to his views on matter, force, and motion, are much like the geometricians who think it impious to cast out Euclid from school-teaching. Both Euclid and Newton have handed down to us in their pages discoveries which will always form a portion of man's intellectual heritage, but the method in which those discoveries are presented will vary from age to age with increasing clearness in man's conceptions of mental and physical processes.

Finally, C. G. K. remarks that my conclusions are "materialistic," by which term I suppose he means that he disagrees with them. As one of the chief objects of the "Grammar" is to cast the term *matter* forth from scientific language, it would have been more correct to say that my conclusions are "idealistic." I fear C. G. K. has a more supreme contempt than the majority of the countrymen of Reid and Hume for an accurate use of philosophical language. KARL PEARSON.

Immunity of the African Negro from Yellow Fever.

THIS point, interesting to anthropologists, is raised anew by a writer on the history of epidemics (NATURE, June 16), who asks whether the alleged protection is supported by all recent authorities. Recent authorities are not so well placed for judging of this matter as the earlier; for the reason that immunity is not alleged except for the African negro of pure blood or unchanged racial characters, and that these conditions of the problem have been much less frequently satisfied in the yellow-fever harbours of the western hemisphere since the African slave trade ceased. However, there was a good opportunity in 1866, during the disastrous yellow fever among the French troops of the Mexican expedition when they lay at Vera Cruz. Among them was a regiment of Nubians, who had been enlisted for the expedition by permission of the Khedive: that regiment had not a single case of yellow fever all through the epidemic. The African negro regiment brought over from the French colonies of Martinique and Guadeloupe had two or three cases, with, I think, one death. The rest of the troops, including Frenchmen, Arabs from Algeria, native Mexicans and Creoles, had no immunity whatever, but, on the other hand, a most disastrous fatality. The medical officers of the French service have recorded the facts principally in the *Archives de Médecine Navale*, their conclusion as to racial immunity being the same that has passed current among the earlier authorities as a truth of high general value (admitting, of course, of exceptions in special circumstances), and a truth that has never, so far as I know, been formally controverted by anyone, although other points concerning yellow fever have been the subject of as obstinate controversy as those touching small-pox itself. The experiences of the French at Gorée, a town with ten times as many negroes as whites, exactly confirmed those of Vera Cruz in the same year (*Arch. de Méd. nav.*, ix. 343).

The immunity of the African negro from yellow fever has become a paragraph in some anthropological text-books. ~~It is~~ from the anthropologists, and not from medical authorities, that Darwin cites the fact in his "Descent of Man," adding an original theory of the immunity, which he was unable to establish after much inquiry. His theory, I need hardly say, was not that "negroes in infancy may have passed through some disease too slight to be recognized as yellow fever,"—whatever that may mean—"but which seems to confer immunity." The theory, however, is another story, or "another volume," as the writer just cited is pleased to suggest; and as for the historical fact of immunity, no one denies it, unless it be Dr. Pye Smith in his recent Lumleian lectures (*Lancet*, April 23, 1892, p. 901), who gives no reasons.

It is unfortunate that the anthropologists (Darwin among them) should have introduced one element of dubiety in placing mulattoes on the same footing, in respect of immunity, as negroes of pure descent, and another in mixing up malarial or climatic fevers with yellow fever. C. CREIGHTON.

June 20.

The Line Spectra of the Elements.

I SEE by Prof. Stoney's letter that I have not yet succeeded in making myself understood, as he does not enter on the subject of my objection. A function of the time may well, with any assigned degree of accuracy and for any length of time, be approximately represented by a sum of circular functions, and nevertheless the periods, amplitudes, and phases may not approach definite values when the length of time for which the approximation is to hold good is increased indefinitely. I think this is quite clear from the example I have given in my last letter (p. 100), and it is not necessary to write out other examples. Now, Prof. Stoney shows how one may find by Fourier's theorem the amplitudes, periods, and phases of a sum of circular functions if one only knows the values of the sum. This deduction is not new to me. I worked out the same equations in a slightly different form, when Prof. Stoney's first letter made me further think about the subject. The deduction does also apply to functions that are approximately represented by a sum of circular functions, but *only under the restriction* that the time for which the approximation holds good is long in comparison to the longest period of the circular functions. In chapter iv. of his paper "On the Cause of Double Lines, &c." (Transactions of the Royal Dublin Society, 1891), Prof. Stoney should have added this restriction. Then the question would naturally have arisen how the restriction follows from Prof. Stoney's hypothesis on the origin of the line spectra. I do not venture to say that it does not, but the author would have to prove it.

C. RUNGE.

Technische Hochschule, Hannover.

The Nitric Organisms.

I MUCH regret to learn from your last issue that Mr. Warington considers that I failed to do justice to his work on this subject in my recent lecture at the Royal Institution, and which was reprinted in your columns of the 9th inst. Mr. Warington complains that I have attributed to Winogradsky, and not to himself, the separation of the nitric ferment; I think, however, that Mr. Warington does not correctly understand the sense in which I employ the word "separate," or rather "isolate" (that is the exact word which I did use), for it does not appear to me that Mr. Warington has ever claimed to have *isolated* this ferment; thus, on referring again to his most recent publication on this subject, I read, "An attempt to isolate the nitric organism by the dilution method failed, but apparently only one other organism—a stout bacillus, growing on gelatin—was present in some of the cultures" (Chem. Soc. Journ., July 1891). In an exhaustive memoir, due reference to the above attempt of Mr. Warington's would, of course, have been made; but in the impressionist sketch, which is alone possible in a Friday evening discourse at the Royal Institution, I take it that a lecturer must be allowed to use his own discretion as to what does and what does not fit into the small frame of sixty minutes without laying himself open to the imputation of having unjustly neglected or emphasized the work of individual investigators. Mr. Warington's name is so indissolubly connected with the subject of nitrification that it is the more surprising to me that he should have taken exception to the passage in question of my lecture.

PERCY F. FRANKLAND.

University College, Dundee, June 21.

Protection against Rain in the Elder.

IT is quite possible that the mode in which the flowers of the elder protect themselves against the rain has been described before, though I do not recollect to have seen any account of it. I have been noticing the great contrast between the aspect of a large elder-tree in full blossom, visible from my study window, presented yesterday and to-day. To-day, which is warm and sunny, every inflorescence is in its normal position, with the flat surface nearly horizontal, so as to get as much sun as possible. Yesterday was cold and very wet, and in every one of the inflorescences the upper part of the stalk was so curved as to bring, as far as the foliage would permit, the surface of the inflorescence to an angle of very nearly 90° with the horizon, so that the rain ran off, and scarcely any of it reached the interior of the flowers.

June 24. **ALFRED W. BENNETT.**

THE TOTAL SOLAR ECLIPSE, APRIL 15–16, 1893.

THE total eclipse of the sun, which will take place during the month of April next year, will most probably be very widely observed, not only because the shadow of the moon passes over such a great stretch of land, but because the phenomenon occurs at the period when a sun-spot maximum is approaching, at which time, of course, the disturbed state of the atmosphere of the sun is on the increase. The maximum time of totality is also in this case considerable, amounting to as much as 4m. 46s.

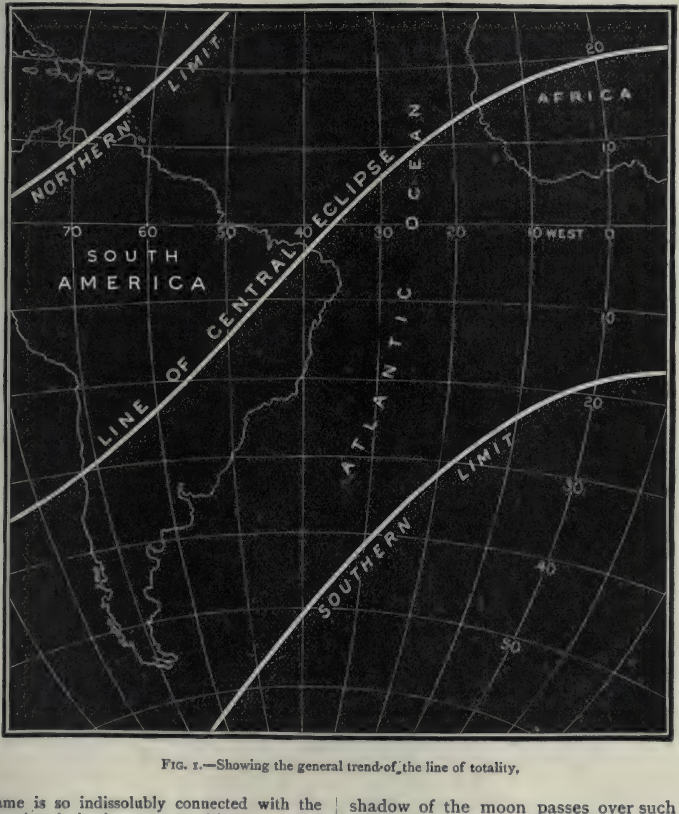

FIG. 1.—Showing the general trend of the line of totality.

Path of Shadow.—The general trend of the path of the shadow will be gathered from the accompanying diagram (Fig. 1). This track cuts through Chili, passes to the north of the Argentine Republic, skirts the provinces of Bolivia and Paraguay, and runs through the heart of Brazil. The centre of the shadow leaves South America near the town of Ceara or Fortaleza, and travels across the Atlantic Ocean, striking the African coast between Cape Verde and Bathurst.

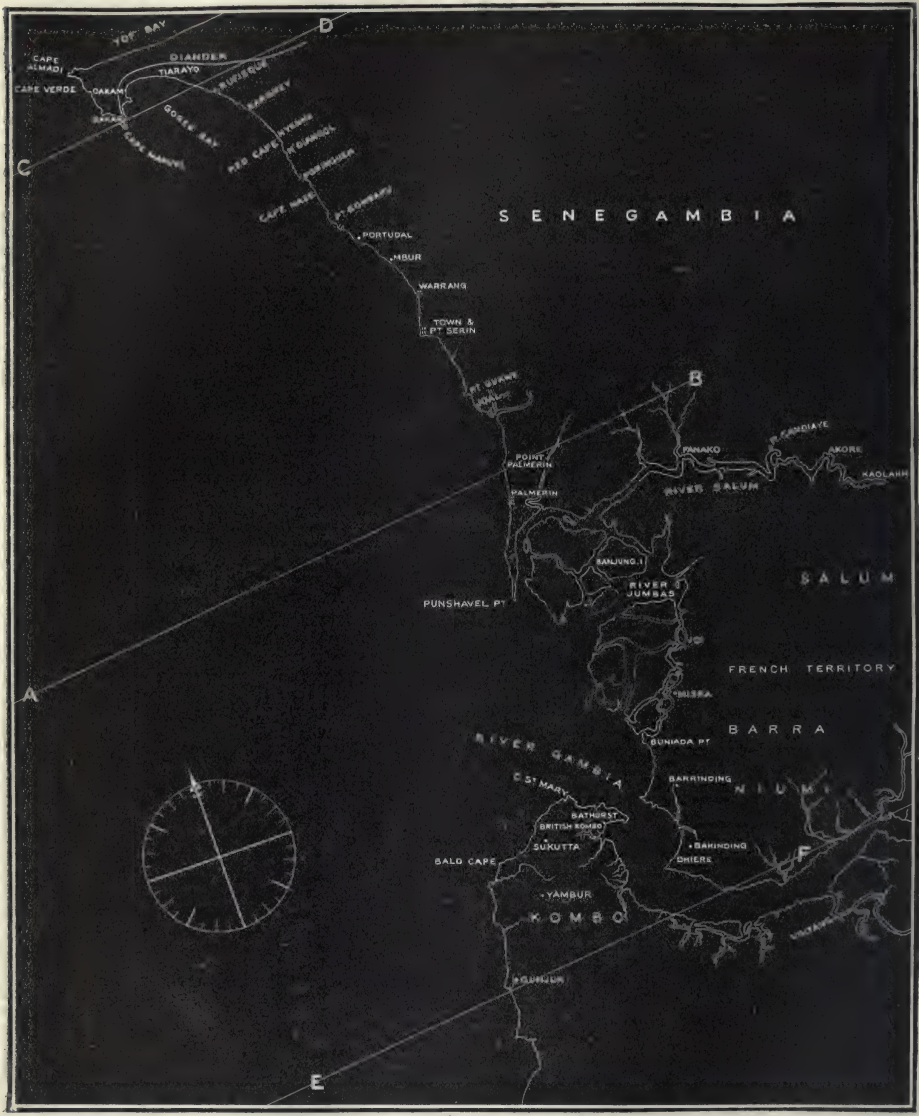

Fig. 2.—Showing the region on the West Coast of Africa over which the line of totality passes.

Probable Points for Observations.—The special points for observations may be said roughly to be three, viz. the region about Chili, the north-east corner of Brazil, *i.e.* the region of Ceara, and the Senegambian coast. These localities are so situated on the line of central and total eclipse that photographs of the corona taken at Chili will precede those taken in Africa by about $3\frac{1}{2}$ hours; while those obtained in the north-east of Brazil will be intermediate between the two.

Let us deal first with the Chilian district; this, we learn, will be occupied by the American astronomers. So far as we know at present, the Lick Observatory will send a party to Chili under the direction of M. Schaeberle, while Prof. Pickering will also direct other observers somewhere about the same spot. To the north of the Argentine Republic, and on the railway which runs up from Buenos Ayres, there seems to be another spot which would be available. This place, Rosario de la Frontera, lies to the north of Tucaman, and to the south of Jujuy, its approximate position being longitude 65° 7′, latitude 25° 48′ S. The duration of totality here amounts to 3m. 8s., the local time of its commencement being April 15, 20h. 40m. This place should, if possible, be made use of, for, besides being easily accessible, the probabilities from all accounts seem to be in favour of fine weather. From observations gathered from the nearest meteorological station, Salta, the mean annual temperature is found to be 63°·6 F., and the rainfall 22·8 inches; the chances for clear weather at this season being estimated at two-thirds.[1]

Following the track of the shadow across Brazil, no suitable spots are reached until the coast is approached; the most favourable place here is no doubt Fortaleza or Ceara, the capital of the province of Ceara, and a city of 20,000 inhabitants. Para Curù is also another very favourable point, lying nearly in the centre of the line of central eclipse; its position is longitude 38° 30′, latitude 3° 42′ S., and the local time of the beginning of the eclipse is April 15, 23h. 40m., the time of its duration being 4m. 44s.

With regard to the weather in this neighbourhood, the chances for clear skies seem, unfortunately, very small. The rainfall is reckoned as over 100 inches per annum, while even in April 10 inches has been usually recorded. For the last five years fifteen days on an average in this month have been rainy, the number in one year reaching twenty-one.

Taking into account the easy accessibility of the place, and its important position on the line of totality, it seems desirable that at any rate there should be some observers there.

Following the shadow over the Atlantic Ocean, we arrive at the shores of West Africa, on which probably both French and English expeditions will take up their respective positions. The accompanying map (Fig. 2) shows the coast-line of this region; AB, CD, and EF indicating the line of central eclipse and the northern and southern limits. The places which seem at present to be the most favourable are Joal and Palmerin, on the coast, if observations there are more convenient than others made inland.

The prospect of fine weather seems to be more probable here than in America. December, January, and February are the cloudy months, the weather during March and April being usually fine; the rains begin about May: sometimes tornadoes occur at intervals of five or six days, being accompanied by heavy rain, lasting generally from one to two hours, leaving the atmosphere afterwards bright and clear. The wind called the "Harmattan" during the first three months of the year is generally from the north-east and dry. It comes from the Sahara Desert, and brings with it consequently minute particles of sand, tending to give the atmosphere a yellowish tint. In April the prevailing wind is westerly to north-westerly, and not usually very strong.

The route which the English expedition will take has up the present not been definitely settled. Several lines of steamers run to Teneriffe and Grand Canary, and if one of Her Majesty's ships picked the expedition up at Teneriffe and carried them either to Bathurst or directly to the Salum River, the matter would be simplified; but failing this the only available route seems to be that by the British and African Steam Navigation Company. These steamers, touching at Madeira, Teneriffe, Grand Canary, Goree, and Dakar, naturally require much time to get to Bathurst. Of the return conditions it seems impossible to get any information at present.

Taking into account the accessibility and proximity to the line of totality, perhaps Palmerin and other places on the same river (River Salum) offer the greatest advantages. The bar at the mouth of the river would prevent a man-of-war of deep draft from proceeding up the river. As the region here is all under French protection, the necessary official letters will of course have to be obtained.

There are one or two other points relating to this region if it should by any chance be ultimately settled upon. Luxuries in the way of tea, sugar, milk (condensed), cocoa and milk, condiments, wine or spirits, flour, biscuits, soups, and preserved meats, should all be brought from England; rice, fowls, sheep, goats, and bullocks being always procurable from the native villages.

Cement and lime should also be taken out, and it seems probable that the huts for the instruments should be constructed at home and carried out there in pieces. The necessary housing of the observers (and escort, if any) would not prove very difficult, for either room could be found in the villages, or bamboo and grass huts could be quickly run up by the natives; it might be advisable to take one or two small tents, as they might prove very serviceable just after landing.

With regard to the packing of the necessary instruments, it may be said that the carriers' loads vary from 40 to 65 pounds; a case capable of being slung on a bamboo can weigh as much as 250 pounds, while to carry a weight of one hundredweight the services of two men would be required. Their wages would, of course, depend on whether they were obtained from Bathurst or the trading wharf on the river at the point of disembarkation, as in the latter case they could be discharged as soon as the selected spot had been reached.

UNIVERSITY OF DUBLIN: TERCENTENARY CELEBRATION.

THE celebration of the tercentenary of the University of Dublin will begin on Tuesday next, and all the necessary arrangements have now been made. Neither the Great College Hall nor the Chapel have been found large enough to hold the number of guests who have accepted the invitation of the Chancellor of the University (Earl of Rosse) and the Provost of Trinity College (Rev. Dr. Salmon), and it has been deemed necessary to hold the Commemoration Service in the Collegiate and Cathedral Church of St. Patrick, and the ceremony of the presentation of addresses in the Leinster Hall, the largest covered area in Dublin. In this hall the College banquet will be given, and the students have also engaged it for a University ball, which is to bring the festivities to a close.

It is expected and hoped that most of the invited guests and delegates will arrive in Dublin in the course of Monday evening, July 4, as the reception by the Provost of Trinity College will be held at 10 o'clock on the Tuesday morning, and immediately after this ceremony the members of the three classes of University officers with the members of the Senate, the other graduates and the undergraduates, will accompany the guests and delegates from the Examination Hall of Trinity College to St. Patrick's Cathedral, a distance of about a mile. Should the weather be fine and the procession properly marshalled, the general effect promises to be as fine as it will in the streets of Dublin be novel.

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[1] The information for the most part concerning the American stations is gathered from Mr. H. S. Pritchett's article, "The Total Solar Eclipse April 15–16, 1·93," in the June number of *Astronomy and Astro-Physics*.

In the afternoon of the same day there will be a garden party in the College Park, to which upwards of three thousand persons have been invited, and the day will close with the performance by the members of the University Choral Society of an ode written by G. F. Savage-Armstrong, and set to music by Prof. Sir Robert Stewart, and by the civic ball.

On the Wednesday morning there will be a special Commencements for the conferring of honorary degrees. The Grace has already passed the Senate for eighty-three degrees, being a number equal to one-third of the total number of the expected guests and delegates. Among those on whom the degree of Doctor of Letters is to be conferred is Prof. Max Müller. The following will receive the degree of Master of Engineering: Lord Armstrong, Sir Benjamin Baker, Sir Isaac Lowthian Bell, Sir Charles William Wilson. The degree of Doctor of Sciences will be conferred on Prof. J. Burdon-Sanderson, Prof. Michael Foster, Prof. Ludimar Hermann, Sir George Murray Humphry, Prof. Julius Kollmann, Prof. Alexander Macalister, Prof. Richet, Prof. Sir William Turner, Wilhelm Waldeyer, Rev. Prof. Thomas George Bonney, Rev. William Henry Dallinger, Sir Archibald Geikie, Othniel Caleb Marsh, Baron Adolf Eric Nordenskiöld, Abbé Alphonse François Renard, John Hall Gladstone, George Downing Liveing, Lord Rayleigh, Prof. Joseph John Thomson, Prof. Thomas Edward Thorpe, Prof. William Augustus Tilden, Francesco Brioschi, Prof. Luigi Cremona, James Whitbread Lee Glaisher, Paul A. Gordan, Edward John Routh, George H. Darwin, Simon Newcomb, Isaac Roberts, F. Tisserand. The following are those who have been selected for the degree of Doctor of Medicine: H.R.H. Duke Charles of Bavaria, John Shaw Billings, Thomas Bryant, Sir Andrew Clark, Adolf Gusserow, Jonathan Hutchinson, Prof. Thomas Grainger Stewart. On the same day there will be a garden party at the Viceregal Lodge in Phœnix Park, given by His Excellency the Lord-Lieutenant and Lady Zetland, and in the evening the College banquet will be held in the Leinster Hall. Five hundred, including all the guests and delegates, have been invited.

Thursday, July 7, there will, in the morning, be a procession, from the Examination Hall of Trinity College to the Leinster Hall, of the College authorities and the delegates and others, to witness the presentation of addresses to the University by the delegates. A delegate from each country will make a short address, and the following have been invited to take their share in this interesting ceremony:—

Great Britain, her Colonies and Dependencies.—Sir James Paget, Bart., F.R.S.
America.—Prof. O. C. Marsh, of Yale University.
Austria-Hungary.—Prof. A. Vámbéry, of Buda-Pesth.
Belgium.—Prof. V. D'Hondt, of Ghent.
Denmark.—Prof. M. H. Saxtorph, of Copenhagen.
France.—Prof. Lannelongue, of Paris.
Germany.—Baron Ferdinand von Richthofen, of Berlin.
Holland.—Prof. Tiele, of Leyden.
Italy.—Prof. Gaudenzi, of Bologna.
Norway.—Prof. Hagerup, of Christiania.
Russia.—Prof. Wedenski, of St. Petersburg.
Switzerland.—Prof. Kollmann, of Basle.
Cambridge.—Dr. Peile, Vice-Chancellor.
Oxford.—Rev. Dr. Boyd, Vice-Chancellor.

On the evening of this day there will be a dramatic performance by the students of the College, the piece selected being Brinsley Sheridan's comedy, "The Rivals." In the afternoon there will be a garden party at the Royal Hospital, Kilmainham, given by the Right Hon. the Commander of the Forces in Ireland and Lady Wolseley.

The ceremonies will be brought to a close on Friday, on which day the following have been asked to address the College students: Profs. W. Waldeyer, Berlin; F. Blass, Kiel; A. Vámbéry, Buda-Pesth; F. Max Müller, Oxford; L. Cremona, Rome; B. J. Stockvis, Amsterdam; Léon Say, Paris; and General F. A. Walker, Massachusetts. The Athletic Union will hold their annual sports in the College Park and the University ball will be given in the afternoon and evening of this day.

On Saturday, July 9, the Royal Society of Antiquaries of Ireland have organized an excursion to Kells, the many objects of great antiquarian interest of which can easily be inspected within the limits of a short day from Dublin; the excursionists will leave the Great Northern Railway Station at 9 o'clock a.m., and return by the train reaching Dublin by 5.30.

Every information can be obtained on writing to the Hon. Secretaries of the Tercentenary Committee, Trinity College, Dublin.

EXHIBITION AT NÜRNBERG BY THE GERMAN MATHEMATICAL ASSOCIATION.

THE following prospectus will show the scope and object of this Exhibition:—

Deutsche Mathematiker-Vereinigung.

München, Mai 1892.

From September 12 to 18, 1892, the meetings of the "Deutsche Mathematiker-Vereinigung" and of the "Gesellschaft deutscher Naturforscher und Aerzte" will be held at Nürnberg.

At the proposition of the "Mathematiker-Vereinigung" the arrangement for an exhibition of models, drawings, apparatus, and instruments used in pure and applied mathematics is proposed. The project has secured the support of the Royal Bavarian Government.

The undertaking already enjoys the co-operation of a number of competent men of science, of several mathematical institutes of our colleges, besides that of various prominent publishers and well-known technical establishments, and thus we may hope that the exhibition will answer the expectations of its founders, viz.:

To open to wider spheres the various auxiliaries used in the instruction and investigation of both pure and applied mathematics in the shape of models, apparatus, and instruments and to forward the interests of this kind of scientific work.

At the request of the committee of the Mathematiker-Vereinigung I have the honour to invite you to participate in the exhibition, and to recommend to your special attention the following directions:—

I. Die mathematische Ausstellung gelegentlich der Versammlungen der "Deutschen Mathematiker-Vereinigung" und der "Gesellschaft deutscher Naturforscher und Aerzte" in Nürnberg will last from September 10 to 18, 1892. It comprises mathematical models, drawings, apparatus, and instruments serving both for teaching and research in pure and applied mathematics.[1]

II. The local committee of the Gesellschaft deutscher Naturforscher und Aerzte resp. the direction of the Bayerische Gewerbemuseum attends to the gratuitous granting of space required by the exhibitors.

III. The Deutsche Mathematiker-Vereinigung takes charge of all furniture, tables, screens, &c., attends to the opening and packing, also for supervision and care during the exhibition and for the insurance against fire. But assumes no responsibility either for damage or for loss of articles.

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[1] In what belongs to the applications, we include only those having principally a mathematical interest. Concerning the experimental part of physics and those instruments, &c., which are of more practical use, it should be mentioned that all those more practical than theoretical relations will be displayed in a second exhibition, separate from ours, which comprises likewise the other branches of natural philosophy and the medicine.

That exhibition, entitled "Fachtechnische Ausstellung," under the authority of the "Gesellschaft deutscher Naturforscher und Aerzte" is arranged by the "Bayerischen Gewerbemuseum in Nürnberg," under the direction of Mr. Th. von Kramer, who has issued special programmes for that exhibition, and from whom further information may be obtained.

IV. Those who desire to exhibit under closed cases must do so at their own expense.

V. The charge of transport (to Nürnberg) and, if desired, the insurance of transport is at the expense of the exhibitor. In what refers to the return transport, by the courtesy of the directors of the Bavarian and the other main lines of German railways free transport is guaranteed for all unsold objects of the exhibition. All expense of home-transport beyond this border is at the expense of the exhibitor.

VI. An explanatory detailed catalogue of the mathematical exhibition is to be issued.

The first part will consist of essays, having reference to problems, results, and methods of geometrical representation.

The second part of an enumeration of all articles exhibited in connection with detailed theoretical descriptions. Here, if desired, the prices may be added. This part of the catalogue will be fully illustrated to give a vivid impression of the exhibited articles. We respectfully request all institutes, publishers, &c., to forward woodcuts, *clichés*, &c., which may be inserted in the text.

An appendix to the catalogue will be published, including all advertisements which may hereafter serve as a directory for all those interested.[1]

VII. As far as possible all technical explanations of the articles will be undertaken by the committee.

VIII. The committee will attend to all sales and buyings (which are in view by various mathematical institutes of our Hochschulen) and give all desired information.

During the exhibition the sold articles must not be removed from the exhibition rooms, except with special permission of the committee.

IX. The intention to participate in the exhibition may be given by the use of the "Exhibition Announcement" until July 1. Address: Herrn Prof. Dr. Walther Dyck, München, Hildegardstrasse 1½.

At the same time all papers and scientific notices for the catalogue respecting woodcuts and *clichés* for illustration must be sent to the same address.[2]

The editors reserve the right of all abbreviation and change in the notes of Part 2 of the catalogue that the uniformity may require.

X. All articles proposed for exhibition must be forwarded from September 1 to 7, under the address: Mathematische Ausstelluug in Nürnberg (Bayern), zu Handen der Herren Danler and Co.

The return of all articles will be effected within two weeks after the close of the exhibition under the conditions fixed above (No. V.)

XI. For nearer information in respect to the intentions and the extent of the exhibition we annex a preliminary classification of the articles.

1. *Geometry. Theory of Functions.*

Models employed in elementary teaching of geometry (solid geometry, trigonometry, descriptive geometry).

Polyhedra. Division of surfaces and spaces in polygons respecting polyhedra.

Plane curves.
Curves in space. Developable surfaces.
Surfaces of the second order.
Higher algebraic surfaces.
Transcendental surfaces.
Models illustrating geometry of complexes.
,, ,, curvature of surfaces.
,, ,, theory of functions.
,, ,, analysis situs.

2. *Arithmetic, Algebra, Integral Calculus.*

Calculating machines. Slide rules.

Instruments for solving equations and for construction of functional relations.

Curvometers, planimeters, integrating machines, instruments for solving differential equations.

3. *Mechanics. Mathematical Physics.*

Models employed in elementary teaching.

Kinematics. Machines for description and transformation of curves and surfaces. Pantographs, perspectographs.

Apparatus for demonstration of mechanical principles.

Equilibrium and motion of a point.

Poinsot motion of a rigid body; precession, nutation; dynamical tops, gyroscopes.

Models and articles showing the effect of stress flexion and torsion of solids.

Elastic properties of solids (especially of crystals).

Hydrodynamics.

Geometrical representations and mechanical apparatus illustrating physical phenomena (for ex. vibrations, wave-motion, propagation of sound and light. Thermodynamic and electrodynamic phenomena).

XII. It is understood that the exhibitors declare their willingness to submit to the present rules and further dispositions ordered by the committee for the interest of the exhibition.

For all further information please address the undersigned delegate of the committee.

Prof. Dr. Walther Dyck,
München, Hildegardestrasse 1½.

For the purpose of collecting and forwarding objects of interest, a Committee has been formed consisting of Lord Kelvin (Chairman), Lord Rayleigh, Profs. Sylvester, O. J. Lodge, G. F. Fitzgerald, W. G. Adams, Sir R. Ball, A. A. Common. Secretaries: A. G. Greenhill, O. Henrici.

The Secretaries will forward prospectuses and forms of application to intending exhibitors, and will take charge of objects at the Central Institution, Exhibition Road, South Kensington, S.W., and forward the objects at the proper time to Nürnberg, unless forwarded direct by the exhibitors.

THE KEKULÉ FESTIVAL AT BONN.

On June 1 a remarkable demonstration took place at the University of Bonn. The occasion was the twenty-fifth anniversary of the call of August Kekulé to the Professorship of Chemistry at that University. The details, which we have taken chiefly from the *Kölnische Zeitung*, will be of interest to the student of chemistry, and probably of value to the future historian of the science.

The ceremony began in the morning with an enthusiastic ovation on the part of the students. The chemical theatre was decorated with plants; on the blackboard figured the benzene hexagon, made up with garlands of flowers, in the midst of which appeared the letters A. K. as a monogram of roses. At the usual lecture hour Prof. Kekulé entered, and was greeted with great enthusiasm. One of the chemical students, Alfred Helle, delivered a graceful address, in which he congratulated his fellows on being privileged to sit at the feet of the greatest of living chemists, ending by calling for three cheers for the Professor, in which the audience heartily joined.

Prof. Kekulé then addressed the students, detailing with characteristic humour some passages in his life. He was, he said, a pupil at the Darmstadt Gymnasium, where he chiefly devoted himself to mathematics. He was destined by his father for the profession of architect, and some houses still existed in Darmstadt, the plans of which he had drawn when a youth at the Gymnasium. At Giessen, where he went to study architecture, he attended Liebig's lectures, whereby he was enticed to chemistry. But his relations would not at first hear of his changing his profession, and he was given half a year's grace to think over it. He spent this time at the Polytechnicum at Darmstadt; from which circumstance arose the myth, affirmed by Kolbe, that he was a "Realschüler," and not, as was really the case, a "Gymnasiast." His first teacher in chemistry at Darmstadt was Moldenhauer, the inventor of lucifer matches. His leisure time was spent in modelling in plaster and at the lathe. He was then permitted to return to Giessen. "I attended," he said, "the lectures, first of Will and then of Liebig. Liebig was at work on a new edition of his 'Letters on Chemistry,' for which many experiments had to be carried on. I had to make estimations of ash of albumen, to investigate gluten in plants, &c. The names of the young chemists who helped Liebig were mentioned in the book, among them mine. The proposal was then made to me, just at the time when Liebig intended to make me his assistant, that I should go for a year abroad, either to Berlin, which at that time was to Giessen a foreign land, or to Paris. 'Go,' said Liebig, 'to Paris: there your views will be widened; you will learn a new language; you will get acquainted with the life of a great city; but you will not learn chemistry there.' In that, however, Liebig was wrong. I attended lectures by Fremy, Wurtz, Pouillet, Regnault; by Marchandis on physiology, and by Payen on technology. One day, as I was sauntering along the streets, my eyes encountered a large poster with the words 'Leçons de philosophie chimique, par Charles Gerhardt, ex-Professeur de Montpellier.' Gerhardt had resigned his Professorship at Montpellier, and was teaching philosophy and chemistry as *privatdocent* in Paris. That attracted me, and I entered my name on the list. Some days later I received a card from Gerhardt; he had seen my name in Liebig's 'Letters on Chemistry.' On my calling upon him he received me with great kindness, and made me the offer, which I could not accept, that I should become his assistant. My visit took place at noon, and I did not leave his house till midnight, after a long talk on chemistry. These discussions continued between us at least twice a week, for over a year. Then I received an offer of the post of assistant to Von Plantu, at the Castle of Reichenau, near Chur, which I accepted, contrary to Liebig's wish, who recommended me as assistant to Fehling at Stuttgart. So I went to Switzerland, where I had leisure to digest what I had learnt in Paris during my intercourse with Gerhardt. Then I received an invitation from Stenhouse, in London, to become his assistant, an invitation I was loth to accept, since I regarded him, if I may be allowed the expression, as a 'Schmierchemiker." By chance, however, Bunsen came to Chur on a visit to his brother-in-law, at whose house I first met him. I consulted Bunsen as to Stenhouse's offer, and he advised me by all means to accept it. I should learn a new language, but I should not learn chemistry. So I came to London, where as Stenhouse's assistant I did not profit much. By means of a friend, however, I became acquainted with Williamson. The latter had just published his ether theory, and was at work on the polybasic acids (in particular on the action of PCl_5 on H_2SO_4). Chemistry was at one of its turning-points. The theory of polybasic radicals was being evolved: with Williamson was also associated Odling. Williamson insisted on plain simple formulæ without commas, without the buckles of Kolbe, or the brackets of Gerhardt. It was a capital school to encourage independent thought. The wish was expressed that I should stay in England and become technologist, but I was too much attached to home. I wished to teach in a German University. But where? In order to get acquainted with the circumstances at the several Universities, I became a travelling student. In this capacity I came, among other Universities, to Bonn. Here there was no chemist of eminence, and hence there were no prospects. Nowhere did there seem so much promise and so great a future as at Heidelberg. I could ask no help of Bunsen. 'I can do nothing for you,' he said, 'at least not openly. I will not stand in your way, but more I cannot promise.' I fitted up a small private laboratory in the principal street in Heidelberg at the house of a corn merchant, Gross by name—a single room with an adjoining kitchen. I took a few pupils, among whom was Baeyer. In our little kitchen I finished my work on fulminate of silver, while Baeyer carried out his researches, which subsequently became famous, on cacodyl. That the walls were coated thick with arsenious acid, and that silver fulminate is explosive, we took no thought about. After two years and a half I received a call to Ghent as ordinary professor. There I stayed nine years, and had to lecture in French. With me to Ghent came Baeyer. Through the kindness of the then Prime Minister of Belgium, Rogier, I obtained the means to establish a small laboratory. I had there with me a number chiefly of more advanced students, among whom I may name Baeyer, Hübner, Ladenburg, Wichelhaus, Linnemann, Radzizewski, and Meyer. There was not so much a systematic course of instruction as a free and pleasant academic intercourse. After nine years' work, I received the call to Bonn." With some account of his work in Bonn, and with a reference to the great attention he had always received from his pupils, Prof. Kekulé concluded his address. The enthusiasm it occasioned, says the *Kölnische Zeitung*, baffled description.

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[1] The fees for insertion in the appendix are 30 Reichsmark for the whole page (great 8°), 18 R.-M. for ½ page, 10 R.-M. for ¼ page, 5 R.-M. for ⅛ page.

[2] All advertisements for the Appendix and payments for same must not be deferred later than August 1, to the same address, Prof. Dyck.

The Professor then received the congratulations of his personal staff, as well as those of the University officials, among whom were the Rector Prof. Strasburger, the Curator Dr. Gandtner, and the Dean of the Philosophical Faculty Prof. Schlüter. In the evening the Bonn students honoured him with a torchlight procession, it being the third time the Professor had received this, the most conspicuous honour which is bestowed by German students. The first occasion was in 1875, when he declined the Professorship at Munich. The second was in 1878, when he was Rector of the University, held to commemorate the restoration of unity among the students after a long period of disunion. Among the torch-bearers on that occasion was the present Emperor of Germany.

In addressing the students, Prof. Kekulé reminded them of the previous occasions on which they had honoured him in like manner, and impressed on them the necessity of guarding and fostering the unity they had attained. Thus ended an impressive and memorable incident in the history of chemical science.

J. E. MARSH.

THE TRUE BASIS OF ANTHROPOLOGY.[1]

THE Nestor of American philologists, and at the same time the indefatigable Ulysses of comparative philology in that country, Mr. Horatio Hale, has just published in the Transactions of the Royal Society of Canada, an important essay on "Language as a Test of Mental Capacity," being an attempt to demonstrate the true basis of anthropology. His first important contribution to the science of language dates back as far as 1838–42, when he acted as ethnographer to the United States Exploring Expedition, and published the results of his observations in a valuable and now very scarce volume, "Ethnography and Philology." He has since left the United States and settled in Canada. All his contributions to American ethnology and philology have been distinguished by their originality, accuracy, and trustworthiness. Every one of them marks a substantial addition to our knowledge, and, in spite of the hackneyed disapproval with which reviewers receive reprints of essays published in periodicals, it is much to be regretted that his essays have never been published in a collected form.

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[1] "Language as a Test of Mental Capacity." By Horatio Hale. From the Transactions of the Royal Society of Canada, 1891.

Mr. Horatio Hale's object in the essay before us is to show that language separates man from all other animals by a line as distinct as that which separates a tree from a stone, or a stone from a star.

"A treatise," he writes, "which should undertake to show how inanimate matter became a plant or an animal, would, of course, possess great interest for biologists, but it would not be accepted by them as a treatise on biology. In like manner a work displaying the anatomy of man in comparison with that of other animals cannot but be of great value, and a treatise showing how the human frame was probably developed from that of a lower animal must be of extreme interest; but these would be works, not of anthropology, but of physiology or biology. Anthropology begins where mere brute life gives way to something widely different and indefinitely higher. It begins with that endowment which characterizes man, and distinguishes him from all other creatures. The real basis of the science of anthropology is found in articulate speech, with all that it indicates and embodies." He does not hesitate to maintain that solely by their languages can the tribes of men be scientifically classified, their affiliations discovered, and their mental qualities discerned. These premises, he says, compel us to the logical conclusion that linguistic anthropology is the only "Science of Man."

These words explain at once the whole character of this important essay. Mr. Horatio Hale is a great admirer of Darwin, but not of the Darwinians. He contrasts Darwin's discernment of the value of language with the blindness of his followers, who are physiologists and nothing else. Why anthropology has of late been swamped by physiology, Mr. Horatio Hale explains by the fact that the pursuit of the latter science is so infinitely the easier. "To measure human bodies and human bones, to compute the comparative number of blue eyes and black eyes in any community, to determine whether the section of a human hair is circular, or oval, or oblong, to study and compare the habits of various tribes of man, as we would study and compare the habits of beavers and bees, these are tasks which are comparatively simple. But the patient toil and protracted mental exertion required to penetrate into the mysteries of a strange language, and to acquire a knowledge profound enough to afford the means of determining the intellectual endowments of the people who speak it, are such as very few men of science have been willing to undergo." Mr. Horatio Hale has a right to speak with authority on this point, for, besides having studied the several languages of North America, of Australia and Polynesia, no one has more carefully measured skulls, registered eyes, measured hair, and collected antiquities and curiosities of all kinds than he has done during his long and busy life. His knowledge of the customs of uncivilized races is very considerable. No one knows the Indian tribes and likewise the Australians better than he does, and he is in consequence very severe on mere theorizers who imagine they have proved how the primitive hordes of human beings, after herding together like cattle, emerged slowly through wife-capture, mother-right, father-right, endogamy, exogamy, totemism, fetichism, and clan systems, to what may be called a social status. He holds with Darwin that man was from the beginning a pairing animal, and that the peculiar usages of barbarous tribes are simply the efforts of men, pressed down by hard conditions, below the natural stage, to keep themselves from sinking lower. He gives a most graphic description of changes of civilization produced by change of surroundings in the case of the savage Athapascans, and their descendants, the quick-witted and inventive Navajos. He holds that the inhabitants of Australia were originally Dravidians, and that their social and linguistic deterioration is due to the miserable character of the island in which they had taken refuge, possibly from the Aryans, when pressing upon the aboriginal inhabitants of the Dekhan. He points out a few grammatical terminations in the Dravidian languages which show some similarity to the terminations of Australian dialects. The dative, for instance, is formed in the Dravidian Tulu by *ku*, and in the Lake Macquarie and Wiradhurei dialects of Australia by *ko*. In both families the *k* of *ku* and *ko* is liable to be changed into *g*. The plural suffix in Tamil is *gal*, in Wiradhurei *galan*. Thus in Tamil *maram*, tree, forms the nom. plur. *marangal*, the dat. plur. *marangaluk-ku*; while in Wiradhurei, *bagai*, shell, appears in the nom. plur. as *bagaigalan*, in the dat. plur. as *bagaigalan-gu*. On this point, however, Mr. Horatio Hale ought to produce fuller evidence, particularly from numerals, and the common household words of uncivilized tribes. The pronouns show many coincidences with Dravidian and Australian languages. No one is better qualified for that task than he is, for we really owe to him the first trustworthy information about the Australian dialects. He considers all the dialects spoken in Australia as varieties of one original speech, and he has proved their wonderful structure by several specimens contained in his first book, published nearly fifty years ago, and again in this last essay of his.

There is no doubt that this essay will provoke much opposition, but no one can read it without deriving most valuable information from it, and without being impressed with the singularly clear and unbiassed judgment of the author. It is to be hoped that if there is any controversy it may be carried on in the same scientific and thoroughly gentlemanlike tone in which Mr. Horatio Hale deals with those whom he has to reprove. Thus, when Prof. Whitney, a fertile writer on linguistic science in America, commits himself to the statement that the Dravidian languages have "a general agglutinative structure *with prefixes only*," Mr. Horatio Hale good-naturedly remarks, "this is doubtless a misprint for *with suffixes only*." And when Prof. Gerland, in his continuation of Waitz's invaluable work "Die Anthropologie der Naturvölker," refers to Mr. Horatio Hale as describing the hair of the Australians as *long, fine, and woolly*, he points out that he, on the contrary, described their hair as neither woolly, like that of the Africans and Melanesians; nor frizzled, like that of the Feejeeans; nor coarse, stiff, and curling, as with the Malays; but as long, fine, and *wavy*, like that of Europeans. He naturally protests against Prof. Friedrich Müller charging him with having committed such a blunder, which, as he remarks, would be as bad as if he had described the Eskimos as having black skins. But there is not a single offensive expression in the whole of his essay, though the opportunities would have been many for adopting the style of hitting indiscriminately above and below the belt. Though he differs from Prof. Whitney, he evidently ranks him very high, and as second only to "that eminent Sanskrit scholar, Sir Monier Monier-Williams."

LEWIS MORRIS RUTHERFURD.

ON May 30 last there passed away from us one whose name was familiar to many, and who was respected and beloved by all who were fortunate enough to have made his acquaintance. By the death of Lewis Morris Rutherfurd, who died at the age of seventy-six, at his estate in Tranquillity, New Jersey, astronomical science especially suffers, for he was one of the pioneers of astronomical photography and spectroscopy, and the introducer of many of the practical methods which have opened to us such a vast field of research.

Born at Morrisania, New Jersey, on November 25, 1816, he first devoted himself to the study of law, but finding his mind bent more on astronomical pursuits, he soon thought fit to leave this profession, and being well equipped with the necessary private resources, he commenced in the year 1848 to erect an observatory in the city of New York at his own residence. On its completion, it was furnished with an 11¼-inch refractor, which he had made under his own personal direction by Fitz, and a transit instrument.

The first work he set himself to do related to the spectra of the stars. As soon as Kirchhoff's discovery was announced, Donati, at Florence, in 1860, made the first efforts in this direction; this was followed by other observers, among whom was Rutherfurd. In 1863 he published his first paper on the spectra of the celestial bodies, and indicated that the various stellar spectra which he had then observed were susceptible of being arranged in different groups. His paper, which was published in *Silliman's Journal*, vol. xxxv. p. 71, contained the following extract with reference to this classification:—"The star spectra present such varieties that it is difficult to point out any mode of classification. For the present, I divide them into three groups: First, those having many lines and bands, and mostly resembling the sun, viz. Capella, β Geminorum, α Orionis, &c. These are all reddish or golden stars. The second group, of which Sirius is the type, presents spectra wholly unlike that of the sun, and are white stars. The third group, comprising α Virginis, Rigel, &c., are also white stars, but show no lines; perhaps they contain no mineral substance, or are incandescent without flame."

Turning his attention to object-glasses for visual and photographic purposes, he described in 1865 a new form which he had specially designed for the latter. This, needless to say, brought about a great revolution in the processes employed. The history of his early attempts to produce photographically corrected object-glasses, and the wonderfully sharp and beautiful photographs of the moon which he finally obtained, will always be marked as an important era in the application of the camera to the equatorial telescope. The photographs taken at the present day, even although they are produced with larger lenses and with a more perfect knowledge of photographic processes, and with the advantages afforded by dry plates, excel only in a trifling degree those taken with the small Rutherfurd equatorial.

Another important piece of work, which occupied him some considerable time, was the mapping, by means of the photographic process, of star clusters and star groups. His ingenuity in devising and constructing accurate micrometers for measuring the impressions of the star clusters opened out a new method by which the proper motion of the stars could be photographically determined, and even their parallaxes, eliminating entirely the errors of observers.

It was absolutely essential, as he knew, in order to obtain a perfect method of measurement of the photographs, to attain the utmost perfection in the cutting of the threads of the micrometer screw, and some idea of the care which he bestowed on them may be gathered from the fact that he took three years to make a single screw. In order to test its quality, it struck him that it would be a happy thought to see if it would enable him to rule a grating. He accordingly set the apparatus up in his bedroom, and by means of an automatic arrangement kept it going all night, as at that time the local vibrations were fewest. The result was that he was able to make the most perfect gratings known, which are only now surpassed by those of Rowland, who followed in his wake.

The photographic corrector, which consisted of an additional lens to be applied to visual object-glasses, to render them fit for photographic use, was also due to his exceptional mechanical ability, and was brought out in the year 1868.

Owing to failing health he was at last obliged to give up all idea of making observations, so he resigned himself to a thorough supervision of the great number of measurements of the photographs of the star clusters that by this time had very considerably accumulated.

In the year 1884, Columbia College, New York, was the recipient of all his astronomical instruments, apparatus, and completed measures. It is only a fortnight ago when a notice of the measures of the Pleiades, which were prosecuted by Mr. Jacoby, under the direction of Prof. Rees, was made in these columns, and it will not be long before several other clusters will be published.

In this brief notice we have only referred to some of the more salient points with which he enriched the domain of astronomical science; and his was no mean spirit striving to confine to his own use the various methods of work and improvements he introduced: he scattered his gratings with a lavish hand among all who were likely to make any use of them, and his greatest delight was to help others occupied in researches kindred to his own.

NOTES.

Sir Archibald Geikie has been appointed by the Council of the Royal Society to be one of the Governors of Harrow School.

It was with deep regret that we saw the announcement in Monday's *Times* of the death of Admiral Mouchez, the Director of the Paris Observatory. In him France has lost one of her most active men of science, whose place it will be no easy task to fill.

At St. John's College, Cambridge, on July 9, at 2.30 p.m., there will be held a meeting of the General Committee that was formed for placing a suitable memorial of the late Prof. Adams in Westminster Abbey. This meeting is specially called to consider a modification in the form of the memorial. The resolution, as passed in February, was to the effect that the memorial should "consist of a bust with tablet and inscription," but as the Dean has been unable to sanction any site in that part of the Abbey in which it was first proposed to be placed, but has offered an excellent position for a medallion, near the monument of Newton and the grave of Sir John Herschel, and close to the memorials of Darwin and Joule, the Executive Committee recommend that this offer be accepted, and that the terms of the former resolution be altered to "That the memorial consist of a medallion and inscription."

The *Botanische Zeitung* publishes a programme of the International Botanical Congress to be held in Genoa. On Sunday evening, September 4, there will be a reception of the foreign botanists present. On Tuesday the Botanical Institute and Garden, presented to the Municipality of Genoa by Mr. Thos. Hanbury, will be formally opened. On Saturday, September 10, the Acclimatisation Garden of Mr. Hanbury at Mortola will be visited. The rest of the week will be occupied by scientific sittings, receptions, and excursions.

Dr. Benecke, the Director of the Experimental Station at Klaten, Java, has offered a prize of 1000 marks for the best essay, founded on original observations and experiments in cultivation, on the causes of the red colour in the fibrovascular bundles of *Sorghum*, which accompanies the disease known as "sereh." A very similar disease has recently become very destructive to the sugar-cane crop in Java.

In our account last week of the Ladies' *Conversazione* of the Royal Society we stated that the Telephone Company's installation was the means by which the music from the Paris opera was rendered audible. This, as we have reason now to know, was incorrect. The Post Office undertook the whole affair, no company having anything at all to do with it.

PROF. BURT G. WILDER, M.D., of Cornell University, sends us the following correction:—In a circular, "American Reports upon Anatomical Nomenclature," issued last winter by Prof. Wilder, as Secretary of the Committee of the Association of American Anatomists, in the third paragraph of the third page, the Chairman of the Committee of the Anatomische Gesellschaft should be Prof. A. von Kölliker, and the Chairman of the American division (appointed in 1891 by the American Association for the Advancement of Science) of the International Committee on Biological Nomenclature should be Prof. G. L. Goodale. Prof. Wilder desires to express his regret for the errors, due in the one case to his own misapprehension, and in the other to a clerical mistake.

UNDER the title of "The Cambridge Natural History," Messrs. Macmillan and Co. have in active preparation an important series of volumes on the Natural History of Vertebrate and Invertebrate Animals, edited, and for the most part written, by Cambridge men. While intended in the first instance for those who have not had any special scientific training, the volumes will, as far as possible, present the most modern results of scientific research. Thus the anatomical structure of each group, its development, palæontology, and geographical distribution, will be considered in conjunction with its external character. Care will, however, be taken to avoid technical language as far as possible, and to exclude abstruse details which would lead to confusion rather than to instruction. The series will be under the general editorship of Mr. J. W. Clark, the University Registrar, and Mr. S. F. Harmer, Superintendent of the Museum of Zoology. The following writers are engaged upon the groups which precede their names:—*Mammals*, Mr. J. J. Lister; *Birds*, Mr. A. H. Evans; *Reptiles* and *Amphibia*, Dr. Gadow, F.R.S.; *Fish*, Mr. W. Bateson; *Mollusca*, Mr. A. H. Cooke; *Polyzoa*, Mr. S. F. Harmer; *Brachiopoda*, Mr. A. E. Shipley; *Insects*, Mr. David Sharp, F.R.S.; *Myriapoda*, Mr. F. G. Sinclair; *Arachnoida*, Mr. C. Warburton; *Crustacea*, Prof. W. F. R. Weldon; *Cœlenterata*, Mr. S. J. Hickson; and *Sponges*, Dr. W. J. Sollas. It is hoped that some of the volumes which are already far advanced may appear in the course of next year. The series will be fully illustrated.

THE weather during the past week has been unsettled, but considerably warmer generally. Towards the close of last week solar halos were visible in the south, and a depression moved along our west coasts in a north-north-easterly direction, accompanied by showers, while the daily temperatures reached upwards of 70° in the inland parts of England. At the beginning of the present week, a still further increase of temperature occurred, the maxima exceeding 80° in the midland and eastern parts of England, and fog became prevalent over the Channel and the southern parts of England. The atmospheric conditions, which during the greater part of the period were cyclonic, with moderate or strong south-westerly winds, amounting to a strong gale from the westward in Caithness on Monday, subsequently became anticyclonic with light north-easterly and easterly winds over England; but on Tuesday evening a depression lay over the mouth of the Channel, the conditions rapidly became more unsettled, and a very severe thunderstorm occurred on that night in London and the greater part of England, accompanied by heavy rain. The *Weekly Weather Report* for the period ending the 25th instant shows that the rainfall exceeded the mean in nearly all districts; in the eastern and southern parts of England the excess was rather large. But reckoning from the beginning of the year there was still a deficit in all districts, although the amount was trifling in the north-east and north-west of England.

A NEW meteorological journal, entitled *L'Atmosphère*, has recently appeared in Paris. It contains several short original articles and miscellaneous notes collected by the director of a private observatory, named Tour Saint-Jacques. At present there is no such journal published in France, excepting the *Annuaire* of the Meteorological Society, containing the papers read by its members. The current number (No. 5) contains an article on the optical phenomena of the atmosphere, by A. Cornu, member of the Institute, and one on solar phenomena and terrestrial magnetism, by E. Marchand, of the Lyons Observatory. It also gives a list of the principal meteorological papers published in recent serials.

A SERIES of severe earthquake shocks is reported from Guodolajara, Mexico. The first shock was felt last Friday night, and lasted eighteen seconds. Windows were broken and plastering cracked in numerous houses, and hundreds of panic-stricken people took refuge in the streets until daylight. On Saturday a second shock occurred, wrecking a number of buildings. Several persons were seriously hurt, but in no case are their injuries expected to prove fatal. Several other shocks have been felt since. The volcano Colima is said to be in a state of much activity. Great volumes of sulphur, smoke, and lava are issuing from the crater.

A PAPER setting forth a proposal for a national photographic record and survey, by Mr. W. J. Harrison, was lately read before the Photographic Society of Great Britain, and has now been issued separately. Mr. Harrison's idea is that a pictorial record of the present condition of the country should be secured by photography, the work being accomplished by professionals, individuals (amateurs), photographic societies, and agencies under the control of the Government. In the course of the paper he gives an interesting account of the way in which the local photo-survey of Warwickshire is being carried out.

ANTHROPOLOGISTS will read with interest some folk-songs and myths from Samoa, printed in the new number of the Journal and Proceedings of the Royal Society of New South Wales (vol. xxv.). They are translated by the Rev. G. Pratt, and introductions and notes are provided by Dr. John Fraser.

PROF. F. STARR will contribute to the July number of the *Popular Science Monthly* an article on "Anthropological Work in America." It will be accompanied by portraits of seventeen American anthropologists. According to *Science*, the article shows that "both in quality and amount, the work of Americans in this field compares favourably with that of Europeans."

A SOCIETY which may have opportunities of doing much valuable work has been formed in Wellington, New Zealand. It is called the Polynesian Society, "Polynesia" being intended to include Australia, New Zealand, Melanesia, Micronesia, and Malaysia, as well as Polynesia proper. The President is Mr. H. G. Seth-Smith, chief judge of the native land court, while the Queen of Hawaii is patron. We have just received the first number of the Society's Journal, in which there are papers on the races of the Philippines, by Elsdon Best; Maori deities, by W. L. Gudgeon; the Tahitian "Hymn of Creation," by S. P. Smith; Futuna, or Horne Island, and its people, by S. P. Smith; Polynesian causatives, by E. T.; and the Polynesian bow, by E. Tregear. There is also a paper giving the genealogy of one of the chieftainesses of Rarotonga, by a native of Rarotonga. The original was written in 1857, and is printed in the Journal, with a translation by Mr. Henry Nicholas, and notes by the editors. The editors are of opinion that the paper "apparently supports by direct traditional testimony the theory propounded by Hale, and subsequently advocated by Fornander, of the occupation of the Fiji Group by the Polynesian race, and of their later migration eastward to Samoa and the Society Group."

THE facility with which enlargements can now be produced, and the introduction of good commercial bromide paper, to say nothing of the artistic effects of the results, have all tended to increase the popularity of the practice of enlarging. When an amateur was formerly in need of moderate-sized pictures, he was compelled more or less to use a large camera, but now the inclination is to employ small cameras and therefore small plates, and to subsequently adopt the enlarging process to give him the required size picture. A very useful and handy little book treating of this process, written by Mr. John A. Hodges, has lately been issued by Messrs. Iliffe and Son, and contains much practical information for working either by artificial light or daylight. Methods of constructing cameras suitable for this work, lanterns, and various accessories, are all very well described and illustrated, and if carefully followed out will render many an amateur independent of the instrument-maker. In the section relating to the chemical manipulations there are also some useful hints which will save a beginner much annoyance and help him to produce satisfactory results.

OBERLIN COLLEGE, Ohio, is issuing a series of Bulletins giving the results of special work done in its museum and laboratories. Two have now been published, the first being a preliminary list of the flowering and fern plants of Lorain County. The second, which we have just received, contains a descriptive list of the fishes of Lorain County, and has been prepared by Mr. L. M. McCormick.

ACCORDING to the *Pioneer Mail* of June 8, the residents of Howrah have been finding lately that jackals are animals of anything but an attractive temper. In some cases they have come right up to the bungalows in search of prey. A little girl, aged about five years, was playing in a verandah, when a jackal suddenly rushed on her, and was dragging her away, when she was rescued. She was severely bitten. Three natives, while walking along Kooroot Road, were attacked by a jackal, which was only driven off after a stubborn fight; and a tale is told of two women, while standing near a tank, being attacked and bitten. So serious has the state of matters become, that the public propose to submit a memorial to the district magistrate praying for the adoption of measures for the destruction of these pests.

REFERRING to Malta's spring visitors, the *Mediterranean Naturalist* for June says that during the preceding month the valleys and gorges were alive with orioles, warblers, rollers, and bee-eaters. In the rich crimson clover enormous numbers of quails found shelter during their sojourn *en route* for the Continent, while the branches and foliage of the carob, the prickly pear, and the orange trees were thronged with harriers and larks.

MR. F. TURNER contributes to the April number of the *Agricultural Gazette of New South Wales* a paper on the carob bean tree as one of the commercial plants suitable for cultivation in New South Wales. The Agricultural Department distributed a quantity of seed last year, and some healthy young plants raised from this seed are now growing in several parts of the colony. Mr. Turner expects that when the tree becomes better known to cultivators it will be extensively grown to provide food for stock, more especially during adverse seasons. The carob can not only be trained into a very ornamental shade tree, but may be planted as a wind-break to more tender vegetation. He advises all who cultivate it to keep bees, if only a single hive. It is astonishing, he says, how many flowers these industrious insects will visit in the course of a day, and be the agency whereby they are fertilized.

SOME time ago a sugar school was established in connection with the State University, Lincoln, Nebraska, and if we may judge from the first formal report, lately submitted by Prof. Lloyd, it is likely to do much excellent work. The school opened on January 5 with twenty-five students. These students were mostly members of other classes in the chemical department of the University; the only preparation required for entrance being a clear conception of the principles of elementary chemistry, such as may be obtained in some of the high schools of Nebraska. The course consisted of two lectures a week, given by Mr. Lyon, with five hours of laboratory work. The lectures embraced the following subjects: (1) chemistry of the sugars; (2) technology of beet-sugar manufacture; (3) culture of the sugar beet. During the latter part of the winter term, Prof. DeWitt B. Brace gave the class four lectures on the theory of light, dealing with (1) the wave theory of light; (2) polarization of light; (3) rotation of the plane of polarization; (4) application of these principles to the polariscope and to the different forms of saccharimeters. It is hoped that in the coming year the work may be greatly extended.

A "Dictionnaire de Chimie industrielle" is being issued in parts, under the direction of A. M. Villon, by the "Librairie Tignol." It gives an account of the applications of chemistry to metallurgy, agriculture, pharmacy, pyrotechnics, and the various arts and handicrafts.

MESSRS. LONGMANS, GREEN, AND CO. have issued a third edition, revised and enlarged, of Prof. E. A. Schäfer's "Essentials of Histology." The intention of the author is to supply students with directions for the microscopical examination of the tissues.

A WORK on the "Migration of Birds," by Charles Dixon, will shortly be published by Messrs. Chapman and Hall.

A PAPER upon the oxidation of nitrogen by means of electric sparks is contributed, by Dr. V. Lepel, to the current number of the *Annalen der Physik und Chemie*. It is well known that small quantities of nitric and nitrous acids and their ammonium salts are produced during the passage of high tension electrical discharges through moist air. Dr. V. Lepel's experiments have been conducted with the view of obtaining more precise information concerning the nature of the chemical reactions which occur, and the experimental conditions most favourable for increasing the amount of combination. The first action of the spark discharge appears to be the production of nitric oxide, which is immediately converted by the oxygen present into nitrogen peroxide. The latter then reacts with the aqueous vapour present, forming nitric acid and liberating nitric oxide in accordance with the well-known equation $3NO_2 + H_2O = 2HNO_3 + NO$. It has been found, however, that the continued passage of sparks through the same quantity of moist air does not result, as might at first sight be expected, in the conversion of more and more of the atmospheric gases into oxidized products. For the passage of sparks through the gaseous oxides of nitrogen first formed results in their decomposition again into their elementary constituents. If, for instance, spark discharges are passing at the rate of one per second, the whole of the nitrogen peroxide molecules have not time to react with the water molecules to form nitric acid, before the passage of the next spark, and hence some of them suffer decomposition; indeed, it is probable that a number of the nitric oxide molecules first formed have not even time to combine with oxygen to form the peroxide before the passage of the next discharge, which brings about their dissociation. Hence it is that, in a closed space, a limit is soon reached beyond which there is no further increase in the amount of nitric acid. For this reason the yield of nitric acid has hitherto been very small. Dr. V. Lepel has made experiments, therefore, with a slowly moving atmosphere, and under different conditions of pressure, and with various types of spark discharge, with the result that he has already increased the amount of combination to 10 per cent. of the total amount of air employed. The air is exposed under increased pressure to a series of parallel spark discharges in the same tube. The change of atmosphere is not made continuously, but intermittently, and the gases are expelled from the discharge tube into a large absorption vessel in which the products are absorbed in a solution of water, or of a caustic alkali. Detailed accounts are given in the memoir of the efficacy of the various forms of high tension discharge, and Dr. V. Lepel is now experimenting with the discharge from a Töpler influence machine with sixty-six rotating plates. Of particular interest are his remarks concerning the probable effect of the high voltage discharges of which we have lately heard so much. He considers it not improbable that by their aid a new mode of producing nitric acid from the atmospheric gases on the large scale may be introduced, rendering us altogether independent of the natural nitrates as a source of nitric acid.

The additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus*) from North Borneo, presented by the Rev. Augustus D. Beaufort; two Small Hill Mynahs (*Gracula religiosa*) from India, presented by Lieut.-Col. W. S. Hore; a Chough (*Pyrrhocorax graculus*) from the Aran Islands, Galway, presented by Miss Balfour; four Sœmmerring's Pheasants (*Phasianus sœmmerringi* ♂ ♂ ♀ ♀) from Japan, presented by Mr. Frank Walkinshaw; an Æsculapian Snake (*Coluber æsculapii*), a Vivacious Snake (*Tachymenis vivax*) from Central Europe, presented by Mr. Alfred Scrivener; a Cayenne Lapwing (*Vanellus cayennensis*) from South America, two Axolotls (*Siredon mexicanus*) from Mexico, purchased; a Ruddy-headed Goose (*Bernicla rubidiceps* ♀) from the Falkland Islands, received in exchange; a Burchell's Zebra (*Equus burchellii* ♂); a Thar (*Capra jemlaica*), a Japanese Deer (*Cervus sika*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Variable Nebulæ.—Mr. Barnard, in *Astronomische Nachrichten*, No. 3097, mentions the cases of two nebulæ which he supposes must be of a variable type. The first has a diameter of about 1′, and appears rather like a comet, the brightness gradually increasing towards the centre, there being no nucleus. Its position for 1889·0 was R.A. 3h. 56m. 17s., Declination + 69° 30′ 38″. The other nebula was discovered by him in 1888, and was estimated to lie between magnitudes 9 and 10, the stellar nucleus being of the thirteenth magnitude. Subsequent observations made in 1891 showed that this nebula had become considerably fainter (13½ mag.), there being still a faint nucleus visible; its diameter was estimated as ½′, while its position for 1888·0 was R.A. 0h. 37m. 55·7s., Decl. − 8° 48′ 6″·5.

Variation of Latitude.—Mr. Chandler, toward the latter end of last year, contributed to the *Astronomical Journal* several articles on the variation of terrestrial latitudes, in which the following points were brought out:—(1) This variation is truly terrestrial. (2) The period of revolution, from 1863 to 1885, of the pole of the earth's figure round that of rotation amounted to 427 days in a west to east direction. (3) About the year 1730, the length of this period was a little over a year. (4) The velocity of rotation is slowly diminishing. In the present number (267) of the same journal he brings together evidence to establish some further conclusions at which he has arrived, basing them on a very considerable number of series of observations. The results may be briefly summarized as follows:—(*a*) About 1774 the rate of angular motion of the pole was a maximum with a daily rate of 1°·034, and since that period the decrease has taken place at an accelerating rate. (*b*) If θ be the daily angular motion and T the interval in days from September 18, 1875, the angular velocity of the polar motion may be put in the form

$$\theta = 0^\circ{\cdot}852 - 0^\circ{\cdot}000\,009\,8\,T - 0^\circ{\cdot}000\,000\,000\,132\,T^2,$$

(*c*) The law of the periodic variation may be expressed as follows:—

$$\phi = \phi_0 - 0''{\cdot}22 \cos [\lambda + (t - T)\theta],$$

where T is the time when the north pole of the earth's figure passes the Greenwich meridian,
E the number of completed revolutions between a given date, t, and the adopted epoch,
θ the daily angular motion,
ϕ the instantaneous value of the latitude of a place,
ϕ_0 the mean latitude,
and λ the longitude of the same place,

the values of T and θ being obtained from the equations—

$$T = 1875 \text{ Sept. } 18{\cdot}5 + 422^d{\cdot}56\,E + 1^d{\cdot}034\,E^2 + 0^d{\cdot}009\,E^3 + 0^d\,000067\,E^4,$$

$$\theta = \frac{360^\circ}{P},$$

when $P = 423^d{\cdot}62 + 2^d{\cdot}0953\,E + 0^d{\cdot}0274\,E^2 + 0^d{\cdot}000268\,E^3.$

(*d*) A sensibly constant angular distance between the poles of figure and rotation during the last fifty years has been maintained.

(*e*) By a comparison of absolute and differential determinations the variation is entirely due to zenithal alterations, and not to a simultaneous variation of the zenith and the astronomical pole.

Comparative Spectra of High and Low Sun.—Mr. Edward Stanford has just published five plates, 16¾ × 19⅝ inches, in portfolio form, of Mr. McClean's beautiful comparative photographic spectra of the high and low sun from H to A. The collotype prints have been reproduced from the mounted photographs by the Direct Photo-Engraving Company, and are enlarged about 8½ times from the original negatives. Published simultaneously also are his comparative spectral photographs of the sun and metals, extending from above H to near D. The two series include the platinum and iron-copper groups.

The Coronoidal Discharges.—The discovery of the presence and power of electricity is, comparatively speaking, very modern, and it is only now we are finding out the diversity of results it is capable of producing. The sun being our great source of heat and light, it is only natural that we should suspect him of having a greater quantity of this form of energy in some way or the other, on a scale, of course, very much greater than ours. In a paper read before the National Academy of Sciences, Washington, and published in the June number of the *American Journal of Science*, Mr. M. I. Pupin describes a series of experiments that he has been carrying out with regard to electrical discharges through poor media. The apparatus which he used is fully described, so we will only refer to the plates which illustrate the points he wished to emphasize. The illustrations are from photographs of discharges taken under conditions under which the solar corona is observed, and suggest in a very striking manner the phenomena that are usually observed at these times. In one case, when the vacuum was very poor, the discharge started in the form of four large streamers, together with large jets, their distribution over the whole surface of the sphere being more or less uniform. The appearance of the sphere "reminded me very much of the granular structure of the sun's disk, . . . and the very luminous points which appeared from time to time . . . reminded me . . . of the sun's faculæ." Further experiments regarding the rotational motion of the streamers lead him to conclude that two discharge streamers tended to blow each other out, "owing to the motion of the cooler gas between them, this motion being produced by the enormous heating effect of the discharge." The figures shown are very striking indeed, and represent the general appearances of the corona during eclipses with a remarkable degree of accuracy.

GEOGRAPHICAL NOTES.

M. Joseph Martin, well-known on account of his explorations in North-eastern Siberia, has died at Marghilan while on a journey in Central Asia.

The Kalahari Desert has been crossed successfully by a "trek" of 150 waggons from the Rustenburg district of the Transvaal, bound for Mossamedes, where an active Boer colony has been established, a large party having embarked at Cape Town to join the overland division. Later reports affirm that a Boer republic has been declared in the plateau region of Angola, one of the healthiest parts of tropical Africa.

THE survey of the district surrounding Aden has been completed by the officers of the Survey of India Department after a very arduous campaign. Work was on several occasions almost stopped by sickness, and by the open hostility of the natives.

STIMULATED by the recent discovery of two complete mammoth carcases in the Government of Irkutsk, the St. Petersburg Academy of Sciences has commissioned Prof. Tcherski, of Irkutsk, to proceed to Yakutsk, on the Lena, and thence, accompanied by Cossacks and pack-horses, eastward to the Kolyma Valley, pushing on if possible this summer to Nizhne Kolymsk in 69° N., returning before winter to Sachiversk on the Indigirka, a town situated on the Arctic Circle. The main object of the expedition is to study the drift geology, but collections will be made in all departments of science, including barometric observations, in order to determine the orography of this rarely visited part of Siberia.

Globus announces the formation of a new islet in the Caspian, near Baku, by upheaval. It lies three and a half miles from shore, and measures 175 feet by 100 feet, rising about 20 feet above the water. Its surface is irregular, and composed of blackish-grey and yellow hardened mud.

WITH reference to the note on p. 65 as to the discovery of a new range of mountains in Benin, it is only fair to former travellers in that region to say that the map by the Intelligence Department, although bearing no mountain shading, has marked upon it "Mt. Ara," very near the position where the range seen by Governor Carter is situated.

THE mountaineering expedition, led by Mr. Conway, to attempt the ascent of the loftiest Himalayan summits, has been making excursions from Gilgit and mapping the Bagrot Valley, but bad weather has prevented any very important climbing from being done. A *Times* telegram from Calcutta conveys news of June 8 from Gilgit, from which it appears that the greatest height yet reached is 17,000 feet, one night having been passed at an elevation of 15,600 feet. The party was about to set out for Nagar, *en route* for Askoley, by the Hissar Pass.

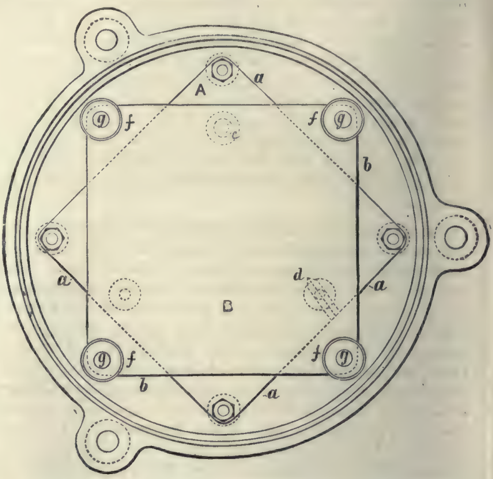
A NEW FORM OF AIR LEYDEN.[1]

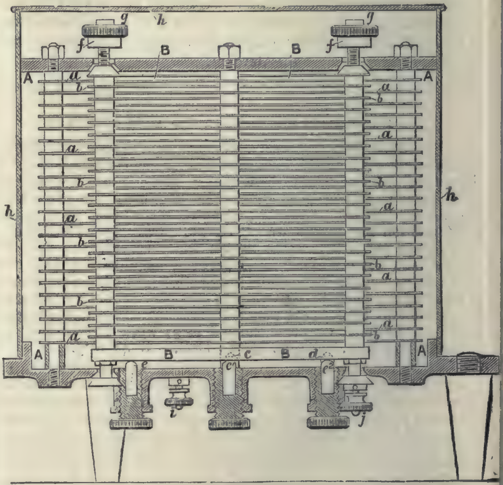
IN the title of this paper as originally offered for communication "*Air Condenser*" stood in place of "*Air Leyden,*" but it was accompanied by a request to the Secretaries to help me to a better designation than "Air Condenser" (with its ambiguous suggestion of an apparatus for condensing air), and I was happily answered by Lord Rayleigh with a proposal to use the word "leyden" to denote a generalized Leyden jar, which I have gladly adopted.

The apparatus to be described affords, in conjunction with a suitable electrometer, a convenient means of quickly measuring small electrostatic capacities, such as those of short lengths of cable.

The instrument is formed by two mutually insulated metallic pieces, which we shall call A and B, constituting the two systems of an air condenser, or, as we shall now call it, an air leyden. The systems are composed of parallel plates, each set bound together by four long metal bolts. The two extreme plates of set A are circles of much thicker metal than the rest, which are all squares of thin sheet brass. The set B are all squares, the bottom of which is of much thicker metal than the others, and the plates of this system are one less in number than the plates of system A. The four bolts binding together the plates of each system pass through well-fitted holes in the corners of the squares; and the distance from plate to plate of the same set is regulated by annular distance pieces which are carefully made to fit the bolt, and are made exactly the same in all respects. Each system is bound firmly together by screwing home nuts on the ends of the bolts, and thus the parallelism and rigidity of the entire set is secured.

The two systems are made up together, so that every plate of B is between two plates of A, and every plate of A, except the two end ones, which only present one face to those of the opposite set, is between two plates of B. When the instrument is set up for use, the system B rests by means of the well-known "hole slot and plane arrangement,"[1] engraved on the under side of its bottom plate, on three glass columns which are attached to three metal screws working through the sole plate of system A. These screws can be raised or lowered at pleasure, and by means of a gauge the plates of system B can be adjusted to exactly midway between and parallel to the plates of system A. The complete leyden stands upon three vulcanite feet attached to the lower side of the sole plate of system A.





In order that the instrument may not be injured in carriage, an arrangement, described as follows, is provided, by which system B can be lifted from off the three glass columns and firmly clamped to the top and bottom plates of system A.

The bolts fixing the corners of the plates of system B are made long enough to pass through wide conical holes cut in the top and bottom plates of system A, and the nuts at the top end of the bolts are also conical in form, while conical nuts are also fixed to their lower ends below the base plate of system A. Thumbscrew nuts, *f*, are placed upon the upper ends of the bolts after they pass through the holes in the top plate of system A.

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[1] "On a New Form of Air Leyden, with Application to the Measurement of Small Electrostatic Capacities." By Lord Kelvin, P.R.S. Read at the Royal Society on June 2.

[1] Thomson and Tait's "Natural Philosophy," § 198 example 3.

When the instrument is set up ready for use, these thumbscrews are turned up against fixed stops, *g*, so as to be well clear of the top plate of system A; but when the instrument is packed for carriage they are screwed down against the plate until the conical nuts mentioned above are drawn up into the conical holes in the top and bottom plates of system A; system B is thus raised off the glass pillars, and the two systems are securely locked together so as to prevent damage to the instrument.

A dust-tight cylindrical metal case, *h*, which can be easily taken off for inspection, covers the two systems, and fits on to a flange on system A. The whole instrument rests on three vulcanite legs attached to the brass plate on system A; and two terminals are provided, one, *i*, on the base of system A, and the other, *j*, on the end of one of the corner bolts of system B.

The air leyden which has been thus described is used as a standard of electrostatic capacity. In the instrument actually exhibited to the Society there are twenty-two plates of the system B, twenty-three of the system A, and therefore forty-four octagonal air spaces between the two sets of plates. The thickness of each of these air spaces is approximately 0·301 of a centimetre. The side of each square is 10·13 cm., and therefore the area of each octagonal air space is 85·1 sq. cm. The capacity of the whole leyden is therefore approximately $44 \times 85\cdot1/(4\pi \times \cdot287)$, or 1038 cm. in electrostatic measure. This is only an approximate estimate, founded on a not minutely accurate measurement of dimensions, and not corrected for the addition of capacity, due to the edges and projecting angles of the squares and the metal cover. I hope to have the capacity determined with great accuracy by comparison with Mr. Glazebrook's standards in Cambridge.

To explain its use in connection with an idiostatic electrometer for the direct measurement of the capacity of any insulated conductor, I shall suppose, for example, this insulated conductor to be the insulated wire of a short length of submarine cable core, or of telephone, or telegraph, or electric light cable, sunk under water, except a projecting portion to allow external connection to be made with the insulated wire.

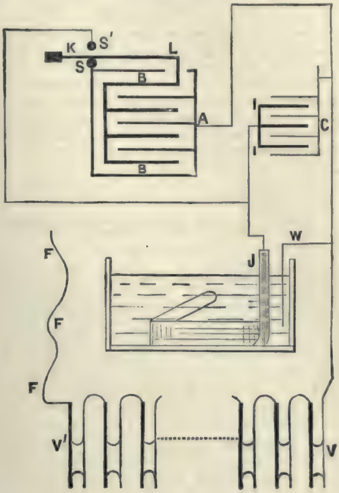
The electrometer which I find most convenient is my "multicellular voltmeter," rendered practically dead-beat by a vane under oil hung on the lower end of the long stem carrying the electric "needles" (or movable plates). In the multicellular voltmeter used in the experimental illustration before the Royal Society, the index shows its readings on a vertical cylindric surface, which for electric light stations is more convenient than the horizontal scale of the multicellular voltmeters hitherto in use; but for the measurement of electrostatic capacity the older horizontal scale instrument is as convenient as the new form.

To give a convenient primary electrification for the measurement, a voltaic battery, *vv*′, of about 150 or 200 elements, of each of which the liquid is a drop of water held up by the capillary attraction between a zinc and copper plate about 1 mm. asunder. An ordinary electric machine, or even a stick of rubbed sealing-wax, may, however, be used, but not with the same facility for giving the amount of electrification desired as the voltaic battery.

One end of the voltaic battery is kept joined metallically to a wire, W, dipping in the water in which the cable is submerged, and with the case C of the multicellular, and with the case and plates A of the Leyden, and with a fixed stud, S, forming part of the operating key to be described later. The other end of the voltaic battery is connected to a flexible insulated wire, FFF, used for giving the primary electrification to the insulated wire J of the cable, and the insulated cells, II, of the multicellular kept metallically connected with it. The insulated plates B of the leyden are connected to a spring, KL, of the operating key referred to above, which, when left to itself, presses down on the metal stud S, and which is very perfectly insulated when lifted from contact with S by a finger applied to the insulating handle H. A second well insulated stud, S′, is kept in metallic connection with J and I (the insulated wire of the cable and the insulated cells of the multicellular).

To make a measurement, the flexible wire F is brought by hand to touch momentarily on a wire connected with the stud S′, and immediately after that a reading of the electrometer is taken and watched for a minute or two to test either that there is no sensible loss by imperfect insulation of the cable and the insulated cells of the multicellular, or that the loss is not sufficiently rapid to vitiate the measurement. When the operator is satisfied with this, he records his reading of the electrometer, presses up the handle H of the key, and so disconnects the plates B of the leyden from S and A, and connects them with S′, J, I. Fifteen or twenty seconds of time suffices to take the thus diminished reading of the multicellular, and the measurement is complete.

The capacity of the cable is then found by the analogy:—As the second reading of the electrometer is to the excess of the first above the second, so is the capacity of the leyden to the capacity of the cable.



A small correction is readily made with sufficient accuracy for the varying capacity of the electrometer, according to the different positions of the movable plates, corresponding to the different readings, by aid of a table of corrections determined by special measurements for capacity for the purpose on the multicellular.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Prof. Liveing announces a course of lectures in general chemistry, to be given during the Long Vacation by Mr. Fenton, beginning on July 7. Mr. Fenton will also give a series of demonstrations on the chemistry of photography.

At the Congregation on June 16, seven graduates in arts were admitted to the degree of Doctor in Medicine, and thirty-one to the degrees of Bachelor of Medicine and Bachelor of Surgery. These are the largest numbers hitherto admitted at one time.

Sir R. S. Ball, Lowndean Professor of Geometry and Astronomy, has been elected to a Professorial Fellowship at King's College.

At Christ's College the following awards have been made to students of natural science:—Scholarships: E. K. Jones (£50), G. A. Anden (£30), J. M. Woolley (£30), C. F. G. Masterman (£50), H. Pentecost (£50), A. M. Hale (£30). Exhibition: A. M. Barraclough (£30). At Emmanuel College:—Scholarship: A. Eichholz (£80). Exhibition: J. C. Muir (£30).

At the annual election of scholars in St. John's College, the following awards in Natural Science have been made:—Foundation Scholarships: W. L. Brown, T. L. Jackson, W. McDougall, S. S. F. Blackman. Exhibitions in Augmentation of Scholarships: Villy, Whipple (First Class Nat. Sci. Tripos, Part II.). Hughes Prize (highest in third year): Villy. Herschel Prize in Astronomy: Pocklington. Hutchinson Studentship for Research in Zoology: E. W. MacBride.

SCIENTIFIC SERIALS.

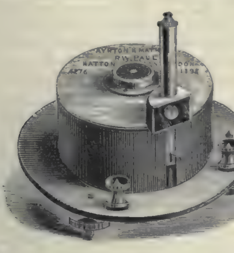
THE numbers of the *Journal of Botany* for May and June appeal almost entirely to students of systematic and descriptive botany:—Mr. F. J. Hanbury continues his notes on *Hieracia* new to Britain, in the course of which he describes three species altogether new.—Mr. Geo. Massee contributes diagnoses of a number of new species of Fungi from St. Vincent, illustrated by three coloured plates.—Mr. E. G. Baker continues his Synopsis of genera and species of *Malveæ;* Rev. Moyle Rogers his essay at a key to British *Rubi;* and Mr. W. A. Clarke his first records of British flowering plants.

IN the *Botanical Gazette* for May are two original papers of interest:—On the archegone and apical growth of the stem in *Tsuga canadensis* and *Pinus sylvestris*, by D. M. Mottier. On the first point the author agrees very nearly with the account by Strasburger; on the second point he is unable to say that there is a single cell at the apex of the stem, unless in the young plant, and even then not with absolute certainty.—Germination of the teleutospores of *Ravenalia cassiæcola*, by B. M. Duggar.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, June 10.—Mr. Walter Baily, Vice-President, in the chair.—Dr. Gladstone read a paper on some points connected with the electromotive force of secondary batteries, by himself and Mr. W. Hibbert. The communication includes replies to certain questions raised by M. Darrieus in a paper read before the Société Internationale des Électriciens on May 4, 1892; and to the views expressed by Prof. Armstrong and Mr. Robertson in the discussion on a paper by the present authors read before the Institution of Electrical Engineers, on May 12 and 19. It also contains an account of their recent experiments on the subject. M. Darrieus agrees with Prof. Armstrong and Mr. Robertson that the large E.M.F. immediately after charge is due to persulphuric acid, and opposes the ordinary theory that the ultimate product of discharge is lead sulphate at both plates, so far as the positive plate is concerned. The authors attribute the finding of large quantities of lead oxide by M. Darrieus to difficulties in analysis, for it is not easy to imagine that oxide of lead could remain as such in presence of sulphuric acid. They have also shown that the changes of E.M.F. during charge and discharge coincide fairly well with those obtained by putting Pb and PbO_2 plates in different strengths of acid, and conclude "that the changes of E.M.F. . . . depend on the strength of the acid that is against the working surfaces of the plates." Prof. Armstrong and Mr. Robertson disagree with the authors' views, and suppose that the sulphuric acid used was contaminated with soluble peroxides; and they also believe that H_2SO_4 itself takes part in the reactions. As regards the first objection, the authors see no reason why the traces of soluble peroxide (if any) on the plates should always vary in amount with the strength of the fresh acid in which the plates were dipped. The second point they leave an open question. In reply to the criticism on the summation of the two curves obtained respectively with two lead plates and two lead peroxide plates in acids of different strengths, they point out that the resulting curve coincides both in shape and magnitude with that determined when a Pb and a PbO_2 plate were placed in different strengths of acid. Whilst admitting the possibility of the lead supports having some influence on the result, they cannot conceive that such large and uniform differences as those given in their paper can be due to accidental operations of local action. To show that the increase of E.M.F. does not depend on the presence or absence of persulphuric acid, the authors have tested the E.M.F. of a Pb and a PbO_2 plate, free from soluble oxides, in sulphuric acid of 15 per cent. strength, a porous diaphragm being between the plates. The E.M.F. was 1·945 volts. After adding 1 per cent. of persulphate of potassium to the liquid surrounding the PbO_2 plate, the E.M.F. was unaltered; whilst putting the Pb plate in the same liquid only reduced the E.M.F. to 1·934. Experiments had also been made on cells with phosphoric acid of different strengths, instead of sulphuric acid. Changing the density from 1·05 to 1·5, raised the E.M.F. 0·176 volt, whilst calculations from Lord Kelvin's law gave 0·171 volt. In this case they consider that no acid analogous to persulphuric acid could be present. They also find that the effects of charging and repose on the E.M.F. of phosphoric acid cells are quite analogous to those obtained with sulphuric acid. The researches are being extended chiefly on the thermochemical side. Prof. Ayrton thought there was no question that the strength of acid had much to do with the changes of E.M.F. The point at issue, he considered, was whether the changes were direct effects of the strength of acid, or due to secondary actions brought about by alterations in strength. Mr. E. W. Smith said Mr. Robertson and himself were repeating the author's experiments with two PbO_2 plates without any grid. They had obtained results analogous to those mentioned in the paper, but the true explanation of the effects was still to seek. Mr. W. Hibbert contended that the soluble oxides referred to by Prof. Armstrong and Mr. Robertson were not present in their experiments. They had also proved that changes in acid strength altered the E.M.F., whilst presence of persulphuric acid did not. Dr. Gladstone, in reply, said they also were making experiments without grids, but had not made sufficient progress to discuss them at present. Mr. Hibbert and himself believed the effects of local action inconsiderable, whilst Messrs. Armstrong and Robertson thought them very important. He hoped that ere long the points would be settled conclusively.—A paper on workshop ballistic and other shielded galvanometers, by Prof. W. E. Ayrton, F.R.S., and Mr. T. Mather, was read by Prof. Ayrton. The galvanometers described were of the type having movable coils and fixed magnets, the advantages of which are well known. In designing the ballistic instruments, their aim had been to obtain sensibility and portability, combined with being screened from external influences, for it was often desirable to measure the magnetic fluxes and fields in dynamos by apparatus near the machines. One of the improvements adopted was the narrow coil described in a paper "On the Shape of Movable Coils, &c.," read before the Society in 1890. Such coils are particularly advantageous for ballistic instruments, for not only can greater swings be obtained by the discharge of a given quantity of electricity through such a coil than with ordinary shaped coils when the periodic times are the same, but even when the same control is used, the same length of wire in the coil, and suspended in the same field, the narrow coil is more sensitive to discharges than coils of any other shape. Another improvement was the use of phosphor bronze strip for the suspensions instead of round wire. For a given tensile strength, both the control and the subpermanent set could be diminished by using strip. In February 1888 the authors made a d'Arsonval of the ordinary type as a ballistic instrument, and found that although it was suitable for comparing condensers, yet for induction measurements the damping was excessive unless the resistance in the circuit was very large. This greatly reduced the sensitiveness. In 1890 they tried one of Carpentier's milliamperemeters as a ballistic instrument, but found it insensitive. A narrow coil instrument made in the same year was found to be sensitive for currents; but as the coil was wound on copper to get damping, it was not suitable for ballistic work. In January 1892 a somewhat similar instrument was constructed for ballistic purposes, and was found very sensitive and convenient. Although the coil had only a resistance of 13 ohms, one microcoulomb gave a swing of 170 divisions on a scale 2000 divisions distant, the periodic time being 2·7 seconds. The instrument could be used near electromagnets or dynamos, and was so sensitive that for ordinary induction measurements very large resistances can be put in series with it, thus reducing the damping to a very small amount. On the other hand, the coil could be brought to rest immediately by a short circuit key. It had the further advantage that it was not necessary to redetermine its constant every time it was used. The chief disadvantage of such instruments was the variable damping on closed circuits of different resistances. This could, however, be overcome by arranging shunts and resistances so that the external resistance between the galvanometer terminals was the same for all sensibilities. A portable ballistic instrument, intended for workshop use, was next described. This had a narrow coil and a pointer moving over a dial whose whole circumference was divided into 200 parts. The instrument had been designed to give a complete revolution for a reversal of a flux of two million C.G.S. lines, but the pointer could turn through two or more revolutions. To test strong fields a test coil with a total area of 10,000 square centimetres is used, and has a trigger arrangement for suddenly twisting it through two right angles. The instrument then reads off directly the strength of field in C.G.S. lines. To vary the sensitiveness in known proportions, resistances are employed. Referring to the improvements made in movable coil instruments since January 1890, when a paper on "Galvanometers" was read before the Society by Dr. Sumpner and the present authors, Prof. Ayrton said Mr. Crompton had greatly increased the sensitiveness of Carpentier's instruments by suspending the coils with phosphor-bronze strip. Mr. Paul had brought out a narrow-coil instrument which combined the advantages of portability, dead-beatness, quickness, and sensibility. Specimens of these instruments were exhibited. The narrow coils are inclosed in silver tubes, which serve to damp the oscillations. Such a coil is suspended within a brass tube which also forms the mirror chamber, and slides down between the poles of a circular magnet fixed to the base. To clamp the coil, a plug mounted on a slotted spring passes through a hole in the brass tube. A tube can be taken out and replaced by another containing a coil of different resistance in a few seconds. An instrument of this kind, with a coil of 300 ohms, gave 95 divisions per microampere, and the damping on open circuit was such that any swing was $\frac{1}{15}$ of the previous one. On comparing recent instruments with those mentioned in the paper on galvanometers above referred to, a distinct improvement is apparent, for their sensitiveness is, for the same resistance and periodic time, as great as that of Thomson instruments. Prof. Perry remarked that the forces dealt with were extremely small. Mr. Swinburne thought that ballistic galvanometers might be regarded as instruments indicating the time integral of E.M.F. rather than quantity. Illustrating his meaning by reference to dynamos, he said that if two machines arranged as dynamo and motor were joined by wires, then, if the armature of the dynamo were turned through any angle, that of the motor would move through the same angle, supposing friction, &c., eliminated. Speaking of figures of merit, he pointed out that the power consumed was the important factor. Prof. S. P. Thompson inquired what was the longest period yet obtained with narrow-coil instruments. The decay of magnetism in large dynamos was so slow that very long periods were required. He himself had used a weighted coil for such measurements. He also wished to know why the figures of merit were expressed in terms of scale divisions on a scale at 2000 divisions distance, instead of in angular measure or in tangents. Mr. E. W. Smith asked what was the length of strip required to prevent permanent set when the deflection exceeded a revolution. Mr. A. P. Trotter thought that, in testing magnetic fluxes by the workshop ballistic instrument, the test coil might be left in circuit instead of putting in another coil. He wished to know what error was introduced by the change of damping caused by the resistance of the circuit not being quite constant. In his reply, Prof. Ayrton said Mr. Boys had pointed out that the scientific way to lengthen period was not by weighting the coils or needles, but to weaken the control. Periods of 5 seconds had been obtained. At present it was not easy to obtain longer periods owing to difficulties in obtaining sufficiently thin strip, and to the magnetism of materials.



Zoological Society, June 14.—Prof. W. H. Flower, C.B., F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of May 1892, calling special attention to a pair of the rare and beautiful Passerine bird the Grey Coly-Shrike (*Hypocolius ampelinus*) from Fao, Persian Gulf, presented by Mr. W. D. Cumming. He also made some remarks on the most interesting objects observed during a recent visit to the Zoological Gardens of Rotterdam, the Hague, Amsterdam, and Antwerp.—A communication from Mr. T. D. A. Cockerell contained particulars of the occurrence of a species of Jacana (*Jacana spinosa*) in Jamaica.—Dr. John Anderson, F.R.S., exhibited and made remarks on some specimens of the Mole-Rat (*Spalax typhlus*) from Egypt.—Prof. Romanes gave an account of some results recently obtained from the cross-breeding of Rats and of Rabbits, and showed that it did not follow that a blending of the characters of the parents was the result of crossing two different varieties.—Prof. Howes exhibited and made remarks on some photographs received from Prof. Parker, of Otago, New Zealand, illustrative of Sea-Lions, Penguins, and Albatrosses in their native haunts.—Dr. Dawson made remarks on the Fur-Seal of Alaska, and exhibited a series of photographs illustrating the attitudes and mode of life of these animals.—Mr. Sclater called attention to the habits of a South African Snake (*Dasypeltis scabra*) as exhibited by an example now in the Society's Gardens.—Mr. Sclater also read some extracts from a letter addressed to him by Mr. H. H. Johnston, C.B., announcing the despatch of a consignment of natural history specimens illustrative of the fauna and flora of the Shiré Highlands.—Mr. W. Saville Kent exhibited and made remarks on some photographs of a species of the genus *Podargus*, showing the strange attitudes of these birds in a living state.—Mr. F. E. Beddard read a paper on the brain and muscular anatomy of *Aulacodus*.—Mr. Gerard W. Butler read a paper on the subdivision of the body-cavity in Snakes, being a continuation of the subject treated of in a memoir on the subdivision of the body-cavity in Lizards, Crocodiles, and Birds, previously read before the Society.—Mr. J. W. Gregory gave an account of his researches on the British Palæogene Bryozoa, of which he recognized thirty species, represented in the National Collection by about 750 specimens.—Mr. Sclater gave an account of a small collection of Birds from Anguilla, West Indies, made by Mr. W. R. Elliott, one of the collectors employed by the Committee for the exploration of the Lesser Antilles.—Prof. G. J. Romanes, F.R.S., read a paper on a seemingly new diagnostic character of the Primates, which was that the terminal joints of both hands and feet in all species of this Order are destitute of hairs. This rule did not apply to the Lemurs.—Mr. O. Thomas read a paper on the genus *Echinops*, of the order Insectivora, and gave notes on the dentition of the allied genera *Ericulus* and *Centetes*.—Mr. G. A. Boulenger gave an account of the Reptiles and Batrachians collected by Mr. C. Hose on Mount Dulit, North Borneo. Amongst these was a fine new Lizard of the genus *Varanus*, proposed to be called *V. heteropholis*. Two new Batrachians were also described as *Rhacophorus dulitensis* and *Nectophryne hosii*.—A paper was read by Lieut.-Colonel H. H. Godwin-Austen, F.R.S., on new species and varieties of the Land-Molluscan genus *Diplommatina*, collected by himself, and more recently by Mr. W. Doherty, in the Naga and Munipur Hill ranges. The author described twenty-seven supposed new species, the most remarkable being *D. unicrenata*, with a peculiarly formed peristome.—A communication was read from Mr. B. B. Woodward on the mode of growth and the structure of the shell in *Velates conoideus*, Lamk., and in other *Neritidæ*. The mode of growth and the structure of this shell were described as follows: Up to a certain point the growth is normal; a change in the direction of growth afterwards takes place, and the test is enlarged by the addition of fresh shelly matter on the exterior of the under side, and by the removal of previously-formed layers on the inner surface. The internal septum that serves the purpose of a myophore was shown to have originated in the paries, which, in the course of growth, had been replaced by the septum. In this respect *Velates conoideus* epitomized in its life-history conditions which are found in distinct recent species of the closely-allied genus *Neritina*. The relations of the paries and septum in this last genus were also described in this paper.—This meeting closes the present session. The next session (1892–93) will commence in November 1892.

PARIS.

Academy of Sciences, June 20.—M. d'Abbadie in the chair.—Phenomena of the residual life of muscle taken from the living being: physiological action of the muscular bases, by MM. Arm. Gautier and L. Landi.—On the influence of mineral filters on liquids containing substances produced by microbes, by M. Arloing.—On the sanitary system adopted by the Venice Conference to prevent cholera from penetrating into Europe through the Isthmus of Suez, by M. P. Brouardel. Four previous conferences for the reform of the quarantine system having failed, that convened at Venice in January 1892 has at last adopted a system chiefly advocated by the French delegates, and practically tested on the Pyrenees frontier during the cholera in Spain two years ago. On that occasion the passengers' linen was disinfected in heating ovens by steam under pressure, and the cholera patients, real or suspected, were isolated. It having been shown that it is practically impossible for a vessel to pass the Suez Canal in quarantine, without contact with the shores, it was resolved that no vessel should be allowed to pass into the Mediterranean unless it was free from infection or had been completely disinfected. Vessels from the Orient which have had no case of cholera since their departure will be allowed a perfectly free passage. Those which have had cases of cholera during the voyage, but none for seven days before arrival, will be allowed to pass the Canal in quarantine if they have a medical officer and a disinfecting stove on board. If not, they will be retained at the entrance of the Canal, where a sanitary station will be erected, and where the disinfection will take place. Infected vessels will be detained at the entrance, the patients will be disembarked and isolated, and the vessels will be disinfected. It is calculated that, out of 16,000 vessels that have passed through the Canal in five years, under the regulations now adopted 28 would have had to undergo a delay of a few hours for disinfection, and 2 would have been detained for a few days.—On the law of correspondence of tangent planes in the transformation of surfaces by curved symmetry, by M. S. Mangeot.—On the distribution of pressures in a rectangular solid charged transversally, by M. Flamant.—On the law of resistance of the cylinders utilized in the crusher manometers, by M. P. Vieille.—On the Doppler-Fizeau method, by M. Moessard. If the relative motions of the source and the observer be alone considered, without reference to the distortion of the wave-front due to motion through the connecting medium, the ratio of the real to the apparent wave-length will be $\frac{V}{V - v + v'}$, where V is the velocity of wave propagation, v that of the source, v' that of the observer. The true formula for this ratio is $\frac{V - v'}{V - v'}$, which, in the case of $V = v$, will differ from the former by infinity.—An examination of the possibility of a reciprocal action between an electrified body and a magnet, by M. Vaschy. Showing that such an action cannot exist unless it be due to a physical quality of the ether different from that implied by the coefficients k and k' in the electric and magnetic laws of attraction, viz. $f = k\frac{qq'}{r^2}$, and $f = k'\frac{mm'}{r^2}$.—Action of nitric oxide on the metallic oxides, by MM. Paul Sabatier and J. B. Senderens. —On a bromo-nitride of phosphorus, by M. A. Besson.—On permolybdic acid, by M. E. Péchard.—On the alteration of preserved ferruginous mineral waters, by M. J. Riban.—On the transformation of gallic acid into pyrogallol: fusion point of pyrogallol, by M. P. Cazeneuve.—On the intestinal calculi of the cachalot (*ambre gris*), by M. Georges Pouchet.—The heliotropism of the *Nauplius*, by M. C. Viguier.—Researches on the proximate composition of vegetable tissues, by M. G. Bertrand. —On the action of some mineral salts on lactic fermentation, by M. Ch. Richet.—On the respiratory exchange, by MM. Chr. Bohr and V. Henriquez. An account of experiments showing that the lungs are not only the seat of the process of gaseous exchange, but also of the oxidation of tissue elements.—Origins and trophic centres of the vaso-dilatatory nerves, by M. J. P. Morat.—Researches on the requirements of the vine, by M. A. Muntz.—On the topography of some lakes of the Jura, the Bugey, and the Isère, by M. A. Delebecque.

AMSTERDAM.

Royal Academy of Sciences, May 28.—Prof. van de Sande Bakhuyzen in the chair.—Mr. Behrens dealt with specimens of brass made by compression of the constituents at ordinary temperature by Prof. W. Spring, Liége, Belgium. One of the specimens, kindly forwarded by Prof. Spring, was of a reddish colour, and had been produced by compressing a mixture of 9 parts of copper and 1 part of zinc; another, pale yellow, by compressing a mixture of 7 parts Cu and 3 parts Zn. Both specimens had been filed up twice, and again consolidated by pressure. The reddish metal was a little softer than common cast brass; it could be somewhat flattened under the hammer. The yellow metal was harder than common brass, and brittle. Both varieties contain a great quantity of yellow alloy, which seems to be in an amorphous state, showing a uniform, finely granular appearance, without any vestige of the beautiful crystallites, so characteristic for copper-zinc alloys, obtained by fusion. Further, a good deal of angular fragments of red copper, some of them cracked and doubled up, with yellow threads between the red lumps and strands, and finally some zinc, angular fragments and threads, trending outwards and uniting near the curved surface of the cylindrical specimens. The metal is nearly, but not wholly compact. There is much that gives evidence of a flow in the yellow alloy and in the zinc, but nothing pointing to a truly liquid state of the alloy or one of its components. Regelation seems to be put aside, while there does not remain any doubt that zinc and copper have been intimately mixed and actually united by repeated filing and compression. One may venture to say, that a more complete union of metallic powders by compression will lead to alloys of most remarkable properties, and may give some alloys that cannot be produced by fusion.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Our Earth—Night to Twilight, vol. i.: G. Ferguson (Unwin).—The Alternate Current Transformer, vol. ii. The Utilization of Induced Currents: Prof. J. A. Fleming (*Electrician* Company).—Essai sur la Vie et la Mort: A. Sabatier (Paris, Babé).—Chambers's Encyclopædia, vol. ix. (Chambers).—Iconographia Floræ Japonicæ, vol. i. Part 2: Dr. R. Yatabe (Tōkyō).—Thermodynamique à l'Usage des Ingénieurs; A. Witz (Paris, Gauthier-Villars).—U.S. Relief Map (Washington).—Bees for Pleasure and Profit: G. G. Samson (Lockwood).—Waterdale Researches; or, Fresh Light on the Dynamic Action and Ponderosity of Matter: 'Waterdale' (Chapman and Hall).—Helen Keller: Souvenir of the First Summer Meeting of the American Association to Promote the Teaching of Speech to the Deaf; second edition (Washington, Volta Bureau).

PAMPHLETS.—Descriptive List of the Fishes of Lorain County, Ohio: L. M. McCormick (Oberlin).—Land Improvement in India: Colonel A. T. Fraser (Bombay, Thacker).—Proposal for a National Photographic Record and Survey: W. J. Harrison (Harrison).

SERIALS.—Journal of the College of Science, Imperial University, Japan, vol. v., Part 1 (Tōkyō),—Journal of the Institution of Electrical Engineers, June (Spon).—Journal of the Polynesian Society, vol. i. No. 1 (Wellington, N.Z.).—Proceedings of the Society for Psychical Research, June (Kegan Paul).—Deutsche Ueberseeische Meteorologische Beobachtungen, Heft 4 (Hamburg).—Journal and Proceedings of the Royal Society of New South Wales, vol. xxv., 1891 (Kegan Paul).—Beiträge zur Biologie der Pflanzen, v. Band, 3 Heft (Williams and Norgate).—Bulletin from the Laboratories of Natural History of the State University of Iowa, vol. ii. No. 2 (Iowa).—Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie, Sechzehnter Band, 1 Heft, Fünfzehnter Band, 3 Heft (Williams and Norgate).—Encyklopædia der Naturwissenschaften, Erste Abthg., 67 Liefg., Zweite Abthg., 69–70 Lief. (Williams and Norgate).

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THURSDAY, JULY 7, 1892.

A SYSTEM OF MINERALOGY.

The System of Mineralogy of James Dwight Dana, 1837–68: *Descriptive Mineralogy*. Sixth Edition. By Edward Salisbury Dana, Professor of Physics, and Curator of the Mineral Collection, Yale University. Entirely rewritten and much enlarged. Pp. lxiii. and 1134. Illustrated with over 1400 Figures. (New York and London: Kegan Paul, Trench, Trübner, and Co., 1892.)

IN the whole history of scientific literature it would be difficult to find a parallel to Dana's "System of Mineralogy," for there is probably no work which, like it, has maintained for more than half a century its position as the best and most complete work of reference on a branch of natural history. In spite of the enormous additions to our knowledge of the chemical and physical properties of well-known minerals, and of the discovery of innumerable new species and varieties, during that long period, the work has been carefully kept up to date; and so thorough and judicious have been the revisions to which successive editions have been subjected, that the book may at the present time fearlessly challenge comparison with the latest and most successful attempts to supply a comprehensive survey of mineralogical science.

When the work first appeared, in 1837, its author made a determined attempt to grapple with the difficult problem of mineralogical nomenclature and classification; like many of his contemporaries, he was sanguine of being able to make the taxonomy of mineralogy correspond with that of the other natural-history sciences, and a so-called *natural* system of classification, based on that of Mohs, was adopted by him. But on the appearance of the third edition in 1850 the futility of all such attempts was admitted, and a scheme of classification founded upon chemical composition was substituted; it is this system of classification which, with some modifications rendered necessary by the progress of discovery, is employed in the present edition.

On reaching its fourth edition in 1854, the work had grown to such an extent that it became necessary to divide it into two volumes: the first devoted to a general introduction to crystallography, with mineral physics and chemistry, and the second to descriptive mineralogy. The necessity for the re-issue of the first of these volumes has been obviated, however, by the publication in 1875 of the "Determinative Mineralogy" by the author's friend and fellow-worker, Prof. Brush, and by the appearance, two years later, of the "Text-book of Mineralogy," in the preparation of which the author had the able cooperation of his son, Prof. Edward Salisbury Dana. In this way the "System of Mineralogy" has now been limited to the descriptive portion of the original work, and only a few pages of introductory matter are given to explain the terminology, symbols, and abbreviations which it has been found necessary to employ. A noteworthy change in the fifth edition, and one which has tended to greatly increase the value of the work for reference purposes, was the fuller recognition and description of varieties, and of the localities from which they have been obtained; the very thorough revision of the historical synonymy, which was undertaken for this fifth edition, also greatly enhanced the usefulness of the book. These historical details and references, which have entailed a vast amount of bibliographical research, have been retained with but few modifications in the present edition.

In the preface to this fifth edition, Prof. Dana wrote in 1868 as follows:—

> "In these and other ways the volume has unavoidably become enlarged. Not a page, and scarcely a paragraph, of the preceding edition remains unaltered, and fully five-sixths of the volume have been printed from manuscript copy. I may here add that, notwithstanding the impaired state of my health, this manuscript—the paragraphs on the pyrognostic characters excepted—was almost solely in the handwriting of the author, or in that of a copyist from it. Neither the consultation of authorities, the drawing of conclusions, nor the putting of the results on paper, has been delegated to another. And being now but half-way between the fifties and sixties, it is my hope that the future will afford another opportunity for similar work."

In writing these lines, Prof. Dana could scarcely have foreseen that the issue of the sixth edition of the work would be delayed for 24 years. During that period three appendices have been prepared by the author, and he has shown, in numerous books and original memoirs on various branches of geology and natural history, an unabated interest and zeal in scientific work. But the very heavy task of incorporating the matter of the appendices into a new edition, and of revising and re-arranging the whole work, has had to be delegated by the author to his son, and certainly it could not have been placed in more competent hands. Every mineralogist will rejoice that the familiar and excellent features of the original work have been carefully preserved. The book, indeed, is so well known to all working geologists and mineralogists, that we cannot do better than to indicate the chief changes which have been found necessary in the present edition, in order to bring it up to date and maintain its high character.

The work now contains more than one-half more matter than the fifth edition, and, to keep it down even to this limit, a very rigid system of abbreviation and condensation has had to be adopted, while the size of the page has been increased by one-fifth. The historical account of the species remains substantially the same as in the last edition, but names commonly employed in important languages, in addition to English, French, and German, have been given.

In the chemical portion of the work very considerable changes have been introduced. The difficult question of the classification of the silicates has received the fullest consideration, and the views of Rammelsberg, Tschermak, and other chemists on each species are clearly indicated. It has no longer been found possible, however, to give a statement of all the analyses that have been made of a species. The microscopic work of Lacroix and others has shown that many of these analyses are worthless, as the material operated upon has been a mixture and not a homogeneous substance. In the present edition all trustworthy analyses of rare minerals have been given, and in the case of common minerals, where the number of published analyses is very great, a judicious selection of the best and most recent analyses has been made.

The statement of the optical constants and the physical characters of minerals has been treated in much the same fashion as the chemical data. The best and most trustworthy determinations have been selected, while measurements of doubtful value have been omitted.

It is on the crystallographic portion of the work, however, that Prof. E. S. Dana has expended the greatest amount of labour. We are informed in the preface that "an attempt has been made to trace back to the original observer the fundamental angles for each species, then the axes have been recalculated from them, and finally the important angles of all common forms have been calculated from these axes." The author is able to state that in every case this recalculation of the angles of all the forms of a mineral has been undertaken, and that no pains has been spared in the verification and correction of the results. The crystal forms are indicated by letters, and the symbols employed are in the first instance those of Miller, and in the second instance the modified form of Naumann's symbols familiar to all who have used the earlier editions of the work. The author gives it as his opinion that the former should eventually supplant the latter altogether. In the hexagonal and rhombohedral system, however, the Bravais-Miller system is adopted in preference to that of Miller.

With few exceptions, the figures of crystals (1400 in number) are new. Many have been drawn from original data, and those taken from other works have been redrawn so as to secure uniformity of projection; the habits of each species and the types of twinning in crystals have been very fully illustrated.

While the general account of the mode of occurrence and association of mineral species has been very carefully attended to, there has been no attempt to make this part of the work exhaustive, for to have done so would have greatly increased the bulk of the volume. The account of American localities—which has always been an important feature of Dana's work, and has made it for North America what the treatises of Kokscharov and Zepharovitch are for the Russian and Austrian Empires respectively—has been greatly added to. The works of Roth and Hintze, with the numerous books and memoirs devoted to the geology of particular regions, now supply all the information that is needed in respect to mineralogical distribution in other areas.

We have tested the volume in many ways as to the completeness and recent nature of the information given with respect to particular species, and always with satisfactory results. To pass such a voluminous mass of information through the press has required eighteen months of labour, and notices of important contributions to our knowledge that have appeared since the earlier pages of the book were printed off have been relegated to a supplement. This supplement, which extends to 28 pages, also contains brief accounts of minerals of unknown composition, and of doubtful species having little or no claim to recognition.

In conclusion, we must congratulate both the original author of the "System," and the writer of the volume in its present form, on the completion of their useful labours. It is not too much to say that the publication of each successive edition of this work has constituted an epoch in the history of mineralogical science; and the present edition, coming from the hands of a new author, completely maintains the prestige of former ones.

J. W. J.

MODERN INFINITESIMAL CALCULUS.

An Introduction to the Study of the Elements of the Differential and Integral Calculus. From the German of the late Axel Harnack, Professor of Mathematics at the Polytechnicum, Dresden. (London and Edinburgh: Williams and Norgate, 1891.)

MR. G. L. CATHCART'S translation forms a handsome volume, and will prove acceptable to those engaged in mathematical teaching, as a storehouse of suggestive methods and ideas for analytical exegesis.

But let us examine the work from the standpoint of the student approaching the subject of the Calculus for the first time, supposing this book to be put into his hands to acquire his first acquaintance with the method and reasoning.

Until very recently the Classics, Greek and Latin, as taught at school, were looked upon chiefly as collections of grammatical examples, and the subject-matter was lost sight of in the careful parsing and analysis of the sentences. Boys were taught on a system which implied that they were all, in their turn, to become schoolmasters and instructors; and the interests of the majority, who would profit intellectually from the literary study of the ancient masterpieces, were completely neglected.

So, too, in Mathematics: the ordinary text-books give an excellent schoolmaster's training in the subject; but the large and increasing class of students, brought into existence recently by the commercial developments of scientific application, who are required to put into immediate practice the theory which they find indispensable, cannot afford the time to be dragged the whole length of the quagmire of the Convergency of Series, of Inequalities, of Discontinuity, and of the so-called Failure of Taylor's Theorem. These are the quagmires in which the mere mathematician delights to lose himself, and also to lure in others after him.

To one who is already very familiar with the notation and operations of the Calculus the present treatise will prove, not repellent, but even fascinating to minds who pursue the subject for its purely analytical interest. Having been over the road before, they will be prepared to appreciate the strictly logical order in which the theorems are developed, starting in Chapter I. with the fundamental conceptions of Rational Numbers, of their Addition, Subtraction, Multiplication, and Division—the subject of Arithmetic in short; and passing on in Chapter II. to Radicals and Irrational Numbers in general. The next three chapters treat of the Conceptions of Variable Quantities, of Functions of a Variable, their Geometric Representation and Continuity; and it is not till the sixth chapter that the Differential Coefficient is introduced and determined for the simplest functions.

But the beginner, who has had the courage to read thus far, will wonder what on earth the subject is all about, even when he has reached the end of Book I., which covers the ground of the subject usually called the Differential Calculus: there are no illustrations, except for one or two meagre geometrical applications, for the mind to hold on by; no diagrams, and no examples to test the soundness of the student's knowledge.

It is true that these collections of examples are decried in certain lofty quarters of the mathematical hierarchy; but the humbler priests of the science, who are in touch with the noviciate mind of human nature, know their practical value; and these collections of problems, formerly a feature of our text-books unknown abroad, are now being extensively copied and adopted in other countries. "In scientiis ediscendis prosunt exempla magis quam præcepta" (Newton).

The Second Book considers Functions of Complex Numbers: we make another fresh start with the operations of Arithmetic, as it is called here; not that any resemblance can be traced to what generally goes by that name. In this book the questions of Convergency, of Single- and Multiple-valued Functions, as illustrated by a Riemann surface, and of their Zeros and Infinities, are gone into at great length; but at the same time the reader will have an impression that the information is given in a very condensed form, and that an attempt has been made to give a brief *résumé* of a subject which requires a large volume to itself.

This Morbid Pathology of the Mathematical Function, as we may call it, requires a very clear, concise, and cosmopolitan tereminology, which, as Mr. Cathcart points out on p. 148, it does not yet possess; it is unfortunate that the nomenclature has mostly been formed originally in the agglutinate German language, and in many cases is only very imperfectly translatable.

This part of the subject, although principally known to us from the researches of later writers, such as Cauchy, Riemann, Dirichlet, and Weierstrass, owes very much to Gauss; but Gauss deserves to lose the credit of priority, from his baneful habit of bottling up his discoveries, after announcing that he had obtained the solution, so as to warn off all other investigators from his preserves of research.

The Integral Calculus is developed in Book III.; here also the treatment, though complete, is very condensed; and but few simple problems and applications are provided to show the use of the subject when the analysis is established.

The author never employs the hyperbolic functions, although their use can be traced back to Newton ("Principia," Lib. II., Prop. ix.); but in the reductions of the integral of $F(x, \sqrt{R})$ where R is the quadratic $a+2bx+cx^2$, the use of $\sqrt{R}$ as the argument in conjunction with the circular and hyperbolic functions enables us to present the different results which arise in a more systematic manner than that employed in the present work. A very short sketch is also given of the method of reduction of the integrals when R is of the third or fourth degree; the elliptic integrals are now introduced, but no mention is made of the elliptic *functions*, introduced by Abel by the inversion of the elliptic *integrals*.

The Fourth Book, which treats of the integrals of complex functions and of the general properties of analytic functions, is probably the sole presentation of this modern and difficult subject in our language. To a mathematician of Mr. Cathcart's development the treatment will appear very concise and elegant, but for our part we miss the footholds afforded by the physical applications of the general theorems of functions; say to Hydrodynamics, such as those recently published by Prof. W. Burnside in the Proceedings of the London Mathematical Society, on Riemann's Theory and on Automorphic Functions, determined from their discontinuities.

The book will recommend itself, as we said at the outset, to the advanced student, who pursues mathematical study as an end to itself, by reason of the strict logical order in which the subjects are presented; but is this strict logical order the most suitable arrangement for a beginner?

Herbert Spencer says that "in each branch of instruction we should proceed from the empirical to the rational." In the operatic version of "Manon" the events are presented in chronological order; but in the original "Histoire de Manon Lescaut" the story begins in the middle, so as to excite the reader's curiosity as to the preceding events which led up to the point at which the characters appear on the scene.

According to Prof. Harnack's preface, the present work may be considered the operatic version of his lectures, while the simple story would appear in the lectures delivered in the Dresden Polytechnicum to his technical students, who required a knowledge of Analysis chiefly as an instrument for the solution of mechanical problems.

Mr. Cathcart explains in his Translator's Note the desire he had to make these lectures accessible to the English reader, and records the regret he felt at the news of the death of Prof. Harnack, while engaged on a revision of his notes for a new edition. The thanks of the mathematical world are due to Mr. Cathcart for the care and trouble he has taken in this valuable piece of work.

A. G. GREENHILL.

ALTERATIONS OF PERSONALITY.

Les Altérations de la Personnalité. Par Alfred Binet. Bibliothèque Scientifique Internationale. (Paris: Ancienne Librairie Germer Baillière et Cie., 1892.)

IN what is in ordinary parlance called somnambulism, or sleep-walking, the patient rises in the night, performs a number of seemingly intelligent actions directed to some special end, answers questions with regard to such actions with a variable amount of coherence, returns to bed, and generally, but not in all cases, wakes in the morning with no remembrance of that which he has done during the night. Such is somnambulism in its narrower sense. It exhibits the individual in an abnormal psychological condition, the actions performed in this abnormal condition being generally unconnected in memory with the normal sequence of events in waking life. The word somnambulism is, however, now used in a wider and at the same time more technical sense, being applied to all cases where the individual, either spontaneously or through hypnotic suggestion, falls into an abnormal condition distinguishable from the normal condition of his or her waking life. It is with the alterations of personality exhibited during the state of somnambulism in this wider sense that M. Binet's volume chiefly deals.

The subject is one that is beset with peculiar difficulties, and one in which extreme caution is necessary in drawing anything like definite conclusions. But it is one that is throwing, and is likely to throw, important side light on normal psychology, and one that may prove helpful in elucidating the difficult problem of the nature of the association of brain and consciousness. It will only be possible in the space at our disposal to indicate the nature of some of the evidence M. Binet adduces, and the interpretation suggested by this learned and lucid writer.

The phenomena of so-called spontaneous somnambulism are somewhat as follows. The patient is, we will say, a dull and melancholy young woman. She falls into a deep and prolonged sleep, or suffers from an hysterical or convulsive crisis. On waking from the sleep, or emerging from the crisis, she is in an altered condition, with little or no memory of her previous life, and no apparent knowledge of her friends and relations. Her character is changed: no longer dull and melancholy, she is bright and merry. In this state she remains for a time, learning anew the ways of the world, and daily profiting by her fresh experiences. Then she falls again into deep slumber, or other crisis, from which she emerges her old self once more, taking up her normal dull and melancholy life just where she left it. She remembers nothing that happened in her abnormal or second state. There is no continuity between the two. Such alterations of personality may continue at varying intervals for many years.

Somewhat similar are the phenomena observed in the somnambulism induced through hypnotic suggestion. M. Janet's subject, Léonie, is a serious and rather sad person, calm and slow, very mild with everyone, and extremely timid. Hypnotized, she becomes a different being. She keeps her eyes closed, but her other senses are abnormally acute. She is gay, noisy, and restless; good-natured, but with a tendency to irony and sharp jesting. In this condition she repudiates her former self. "That good woman is not myself," she says, "she is too stupid!"

M. Binet, summarizing the principal modifications of memory in hypnotic somnambulism, says that the subject, during the normal condition, remembers nothing of the events which have taken place during somnambulism, but that, when hypnotized, he may remember not only the occurrences in former somnambulisms, but also those which belong to the normal state. There is thus some continuity of the normal into the hypnotic personality, but none from the hypnotic to the normal. "Le livre de la vie somnambulique se ferme au réveil, et la personne normale ne peut pas le lire."

But though there is no conscious memory in the waking state of what has occurred during somnambulism, it is said to be possible to unseal the register thereof through automatic writing. A fact is told to the subject in the state of somnambulism under hypnosis, and the subject is then restored to the normal state. He has no recollection of the fact, and knows nothing about it. But slip a pencil between his fingers, hiding the hand from his eyes by means of a screen, and he will write down the fact automatically (Gurney).

In cases of so-called "negative hallucination", or "systematic anæsthesia," the subject under hypnotic suggestion neglects and is apparently blind to certain objects. For example, two out of a number of blank cards are marked with a cross, and the subject is made blind to these. If she be given a dozen cards, and among them these two, and if she be asked to count the cards, she will neglect these two and reply that there are ten. But if a pencil be slipped between her fingers, and she be asked in a low voice how many cards there are, she will reply, in automatic writing, *two*. And if she be asked, in the same tone, why she said ten and neglected these two, she will write in reply that "she could not see them."

On the basis of such observations as are here briefly summarized, and others for a description of which we must refer our readers to the book itself, M. Binet contends that, associated with the same physical individual, there may be two (or more) personalities, both of which are conscious. They may be co-existent or successive. Anæsthesia is the barrier which separates co-existent personalities: amnesia the barrier which separates successive personalities. "En un mot, il peut y avoir chez un même individu, pluralité de mémoires, pluralité de consciences, pluralité de personnalités; et chacune de ces mémoires, de ces consciences, de ces personnalités ne connaît que ce qui se passe sur son territoire." We do not propose to discuss this position. Suffice it to say, that for ourselves we see no satisfactory evidence of the *co-existence* of two personalities *both of which are simultaneously conscious*. Strange alterations and modifications of personality may occur under peculiar circumstances; but this is something very different from the supposed co-existence of two or more distinct consciousnesses.

C. Ll. M.

OUR BOOK SHELF.

Volcanoes: Past and Present. By Edward Hull, M.A., LL.D., F.R.S. With Forty-one Illustrations and Four Plates of Rock-sections. (London: Walter Scott, 1892.)

In this new volume of the "Contemporary Science Series," Prof. Hull has given a very readable account of the phenomena of volcanoes and earthquakes. A short introduction to the subject of vulcanology is followed by a sketch of the active and extinct volcanoes of Europe, and this by an account of some of the "dormant or moribund volcanoes of other parts of the world." From this description of recent volcanoes, the author proceeds to the consideration of the Tertiary volcanic districts of the British Islands, and the pre-Tertiary volcanic rocks of our own and other countries. The two concluding chapters of the book are devoted to a consideration of the remarkable eruption of Krakatão in 1883, and the great earthquakes which during the last few years have attracted so much attention, with a discussion of some of the volcanic and seismic problems suggested to the author by his review of the phenomena. These problems are classed by the author under the following heads:—"The Ultimate Cause of Volcanic Action," "Lunar Volcanoes," and the question: "Are we living in an Epoch of special Volcanic Activity?" An appendix gives "A Brief Account of the Principal Varieties of Volcanic Rocks."

In a little book of 270 pages it has of course been impossible for the author to do full justice to such a wide circle of topics, and it is sometimes difficult to detect the principle on which certain subjects have been included, and others rejected by him. But the author may be fairly credited with having accomplished his main object, which he has defined as follows: "To illustrate the most recent conclusions regarding the phenomena and origin of volcanic action by the selection of examples drawn from districts where these phenomena have been most carefully observed and recorded under the light of modern geological science."

An admirable feature of the work is the recognition of the principle that vulcanological problems may often be better attacked by the study of ancient and greatly denuded volcanoes, rather than by the examination of those in actual activity, or of such as have recently become extinct.

"*Encyclopédie scientifique des Aide-mémoire*":—
Résistance des matériaux. Par M. Duquesnay.
Étude expérimentale calorimétrique de la machine à vapeur. Par V. Dwelshauvers-Dery.
Air comprimé ou raréfié. Par Al. Gouilly.
(Paris: Gauthier-Villars, Georges Masson.)

THESE three little hand-books on their respective subjects are made by the separate publication of the respective articles of the "Encyclopédie scientifique"; it is intended that each subject is to appear in a separate volume at a rate of publication of thirty to forty a year.

There is no indication by numbering as to the order of appearance, so that probably these are the pioneer volumes.

The first volume, "La résistance des matériaux," gives a very clear and concise account of the practical side of Elasticity, so far as required by the engineer in the design of beams, columns, bridges, and retaining walls.

Prof. Dwelshauvers-Dery is well known for his theoretical and experimental researches on the Steam Engine, and his treatise may be considered as the application of the empirical laws of saturated vapours to the theoretical determination of the useful effect obtainable in the different forms of steam engine, simple or compound, with an attempt at the evaluation of the loss due to conduction. The results arrived at are checked by comparison with long-continued steam-engine trials carried out by Hirn, Donkin, Longridge, and the author himself.

The third volume, on "Air comprimé," may be supposed to carry out the same development of abstract Thermodynamics when the medium is supposed to behave as a perfect gas. In this case the mathematical laws, developed at the outset, are capable of more ready and immediate application; and the second half of the book gives a detailed account of the employment of air as the medium for the transmission of energy in its various industrial applications—for instance, as laid on in Paris compressed in mains, or as employed when rarefied in the Westinghouse brake.

A useful feature in these books is a page at the outset, in which the notation to be subsequently employed is carefully explained.

The Mechanical Equivalent of Heat is taken as 425 kilogrammetres, presumably at Paris; the mean of Prof. Rowland's experiments gives about 427 Baltimore kilogrammetres, or in absolute measure about 42 million ergs, or 4·2 joules.

The "Encyclopédie" is to be divided in interest between the *section de l'Ingénieur* and the *section du Biologiste;* the volumes promised in the first section, as in course of preparation, will constitute a valuable technical working library. G.

Chambers's Encyclopædia. New Edition. Vol. IX. (London and Edinburgh: W. and R. Chambers, 1892.)

THE new edition of this admirable Encyclopædia is now approaching completion, and in the present volume there is certainly no falling-off in the ability with which the work has hitherto been written and edited. On all important subjects represented by words between "Round" and "Swansea" there are articles summing up the latest results of research. An excellent article on round towers, by Dr. Joseph Anderson, is given on the first and second pages. This is a model of what such a paper ought to be. The author knows his subject thoroughly, and consequently understands where to draw the line between ascertained facts and the theories based upon them. Another well-arranged archæological contribution by Dr. Anderson is the paper on sculptured stones. Dr. John Murray writes with his usual lucidity on the sea and on sounding. The task of expounding the facts and laws relating to sound and to the spectrum has been intrusted to Prof. Knott, and the Rev. E. B. Kirk contributes the articles on the sun and the stars. Dr. Buchan is the author of a clear and interesting paper on storms. Other scientific articles which may be specially noted are those on the Silurian system, by Prof. James Geikie; on the skull, by Dr. D. Hepburn; on the snail and the slug, by Mr. T. D. A. Cockerell; on snakes and spiders, by Mr. J. A. Thomson; on the steam-engine, by Prof. A. B. W. Kennedy; and on the steam-hammer, by Prof. T. H. Beare. Among the geographical contributions are articles on Russia, by Prince Kropotkin; on Siam, by Mr. J. S. Black; on South Australia, by Mr. J. Bonwick; and on Spain, by the Rev. Wentworth Webster.

A Guide to Electric Lighting. By S. R. Bottone. (Whittaker and Co., London, 1892).

IN this work the author gives a general idea of the various methods of electric lighting, without entering into any of those technicalities which tend to confuse rather than enlighten the ordinary reader. Commencing with descriptions of the various batteries that are now employed, he discusses their particular advantages and disadvantages, adding also a table of their E.M.F., currents, and resistances.

The second chapter, which is devoted to the production of currents by means of the dynamo, will enable the reader to form some idea as to the selection of one of these machines for a given purpose, and to understand its general principles. Perhaps the chapter on electric lamps and accumulators will be found the most serviceable, for one is brought far more into contact with them than with dynamos themselves. The information here will enable anyone to set up a small installation for himself, while a very useful table shows the dimensions, capacities, weights, &c., of accumulators suitable for such work.

The remaining chapters deal with the descriptions of some of the smaller appliances necessary in connecting up the supplier of electricity, whether it be dynamo or accumulator, with motors or transformers, and last but not least with an excellent *résumé* of the cost of maintenance, showing the relative prices of gas and electricity as now regulated.

The book contains numerous illustrations, and as a thoroughly practical and handy work should be widely read.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

"The Grammar of Science."

TO the vast majority of readers, chapter ix. of the "Grammar of Science" will probably seem to be simply a plea in favour of the doctrine of evolution in its purest form. We were not called upon to express any opinion as to the merits of this doctrine, nor did we. What struck us (and still strikes us) as fundamentally illogical, was the formulation of a theory, which, itself avowedly a mental product, proceeded to picture a universe devoid of sentient beings, or, in the phraseology of the "Grammar," a conceptual world evolving the perceptive faculty which creates it. An evolution theory which postulates spontaneous generation and human automatonism is natural to the materialist; and hence our contention that, in spite of the general character of the argument in the earlier chapters of the book, certain conclusions are distinctly materialistic.

Again, we are not of those who would bind down all time to Newton's views on matter, force, and motion. That never has been the position of those whom Prof. Pearson delights in nicknaming the Edinburgh school. Only we think a writer should be careful as to what he imputes to Newton. Thomson and Tait say, "We cannot do better, at all events in commencing, than follow Newton somewhat closely": and unless they have misrepresented the teaching of the "Principia," an attack on their version surely amounts to an attack on Newton. Indeed, Prof. Pearson fully realizes this himself, when, on p. 382, he accuses Newton of thinking of "force in the sense of mediæval metaphysics as a cause of change in motion." It was this statement we took exception to. Similarly, we cannot but look upon Prof. Pearson's obvious jeer at Maxwell's language as of the same gratuitous character.

"Matter is, as it were, the plaything of force"—this evidently Prof. Pearson regards as his trump card. Now these words—and note the "as it were"—occur in the discussion of Newton's laws of motion, and are obviously suggested by Newton's own anthropomorphic language. But they can give rise to no misapprehension in the mind of one who is reading Prof. Tait's "Properties of Matter" for profit. In the light of the introductory chapter there is really no room for other than wilful misrepresentation of Prof. Tait's position. Moreover, it is positively astonishing to find an author, who has no slender claims to the title of historian, confessing his ignorance of Prof. Tait's lecture on "Force," delivered before the British Association in 1876, and published in NATURE, vol. xiv. (see also "Recent Advances," third edition, and Maxwell's "Life," p. 646). That lecture was, we think, the first popular exposition of the subjectivity of force. The recognition of this truth was, of course, a natural consequence of the remarkable series of discoveries which brought home to the mind that energy was physically as objectively real as matter. We certainly did not need to go all the way to Berlin to learn it. C. G. K.

On the Line Spectra of the Elements.

I OBSERVE from Prof. Runge's last letter that on one point I was led into misinterpreting his meaning by his having used the letter *j* in his second formula on p. 100 (NATURE of June 2) in a sense different from the only definition that had been given of that symbol, viz. the jot of time—the time that light takes to advance one-tenth of a millimetre in the open æther. The period of time represented by *j* is as determinate as a day or hour. With it, Prof. Runge's equation represents one definite discontinuous motion along the sloping sides of the teeth of a particular saw, and this is what I understood by it. I perceive now that he intended *j* to be interpreted in a new sense, and meant the equation to represent uniform motion in a straight line to an *indefinite* distance.

If all that Prof. Runge wishes to point out is that motion along an orbit that extends to infinity must be either wholly incapable of being represented by a Fourier's series, or at least must contain a component of that kind, this is both true and obvious; and the instance he gives (which is, in fact, uniform motion to an unlimited distance along a straight line) is a case in point. But it should be added, no such component of the motion of an electric charge which does not yield to Fourier's theorem can produce any periodic disturbance in the æther: in other words, *it would not contribute anything to the spectrum.* Accordingly, any such part of the motion—for instance, the advance, in common with the rest of the solar system, of the electrons within the molecules of a gas on the earth, at the rate of eight miles a second, towards the constellation Hercules, which is the precise kind of motion that Prof. Runge adduces as an instance—has nothing whatever to do with the subject of my memoir, which is an investigation into the cause of double lines *in spectra.* It should further be added that unlimited motions of any kind have nothing to do with motions going on *within molecules*, to the investigation of which chapter iv. of my memoir is devoted, and that any discussion of them there would have been out of place.

Hence, to represent as a defect which vitiates my reasoning, as Prof. Runge does, that I have omitted in that chapter to refer to the motions which are not resolvable by Fourier's theorem, is, I submit, not legitimate criticism, especially as the matter, beside being irrelevant, is obvious; and I also submit that to say "A plausible suggestion about the movement of the molecules ought to explain more than one of the observed phenomena" (NATURE, April 28, p. 607) is not criticism at all. We must use the data furnished by our observation of nature to carry us as far as they will go in the interpretation of nature, and not refuse to employ them to that extent because they do not enable us to get further.

G. JOHNSTONE STONEY.

9 Palmerston Park, Dublin, July 2.

Range of the Sanderling in Winter.

As my little contribution to the *Records of the Australian Museum* has been honoured by a notice in NATURE (*suprà*, pp. 177–78), I must ask leave to qualify two statements therein made. Since I wrote it I have become aware that Dr. Finsch had a specimen of the Sanderling (*Calidris arenaria*) brought to him at Bonham Island, one of the Marshall Group, which lies within the tropics (*Ibis*, 1880, p. 331); and, after the publication of Mr. Everett's list of the birds of Borneo in 1889, that gentleman announced the occurrence of this species at Baram, on the north-east coast of that island (*Ibis*, 1890, p. 465). ALFRED NEWTON.

Magdalene College, Cambridge, June 25.

Immunity of the African Negro from Yellow Fever.

DR. CREIGHTON will find that on p. 51 of a report dated 1890, "On the Etiology and Prevention of Yellow Fever," Dr. George M. Sternberg (Lieut.-Colonel and Surgeon U.S. Army) makes the following statement:—

"It has been asserted that the negro race has a congenital immunity from yellow fever, but this is a mistake. The susceptibility of the negro is, however, much less than that of the white race. Amongst those attacked the mortality, as a rule, is small."

He will also find the subject discussed on pp. 166–67 of "A Contribution to the Natural History of Scarlatina," by Dr. D. Astley Gresswell (Clarendon Press, 1890). Dr. Gresswell writes thus:—

"The African negro of pure descent was supposed to be insusceptible to the virus of yellow fever and of malaria. It is said, however, that when these affections are prevailing in a virulent form the negro does become infected and manifest such infection. This would suggest that the almost complete immunity in the case of the negro has been acquired. Moreover, the fact that negroes of pure descent are more likely to manifest the symptoms of yellow fever on exposure to the poison after they have passed some years or some generations in more temperate latitudes, in which the disease is not indigenous, suggests that in order to maintain this degree of immunity it is necessary that the negro should continue to live in localities in which the virus exists; in other words, that the individual or the race should be repeatedly subjected to the virus. It may, in fact, be questioned how far, in regard to these diseases in man, susceptibility differs independently of protection acquired by previous subjection to the action of the virus or its products; though natural selection may (as certain facts indicate) have acted more directly. Indeed, it is quite possible that protection acquired by previous infection is much more frequently a cause for benignity or only partial susceptibility in the case of these and other infection-diseases than is generally allowed for."

I do not think I can with advantage add anything to these quotations. YOUR REVIEWER.

A Solar Halo.

IN connection with the heavy thunderstorms further south, possibly, there was here the most brilliant solar halo on the 29th which I have seen. The wind was easterly all the time, causing sea-fog-like clouds in the morning, which dissipated by degrees about 10, but I did not notice the halo before 10.45, nor after 3.30 or 4 o'clock. It was certainly gone at 5.

Though a complete halo at 11, it was far intenser above and below, the north-west and south-east octant especially. By 1 o'clock this had shifted to the north-east and south-west octants.

Between 11.45 and 12 the south-east octant of the outer halo (red inside) was also visible.

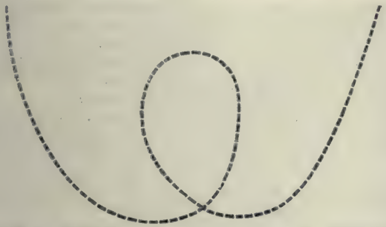
Until 1 o'clock the figure was practically circular, the inner space being remarkably free of colour, the blue of the sky assuming an ashy grey tint. By 2 the figure was elliptical, the long axis horizontal, and the halo *not complete*. The ellipticity increased as the sun sank. Hence the visible part was evidently formed of the *tangent arcs*. No doubt the intense brilliancy near noon was due to these arcs practically coinciding with the ordinary halo, because of the sun's great altitude.

J. EDMUND CLARK.

4 Lorne Terrace, Edinburgh, June 30.

The Electric Current.

DURING the thunderstorm last evening, in the middle of the brilliant flashes which illuminated the south-eastern sky, I noticed the electric current assume the following remarkable form:—



Burlington Fine Arts Club,
17 Savile Row, W., June 29.

EDWARD HAMILTON.

Are the Solpugidæ Poisonous?

AT a recent meeting of the Linnean Society (June 2), I had the honour of exhibiting the jaws, claws, and hairs of a species of Galeodes from Tashkend, in order to show certain peculiarities, which perhaps throw light on the question as to whether these animals are poisonous or not.

Murray, in "Economic Entomology," says: "Their bite is said to be venomous, and even dangerous, but proof of this is wanting."

It is, further, always the natives in both the Old and New Worlds where this "spider" occurs who give it its bad reputation, and always the European immigrant or settler who either doubts or even positively denies it.

In spite of the well-known fact of the persistence of groundless terrors in the minds of uncivilized peoples, I should still be inclined to think that, in a case of this kind, which is one of raw experience, the natives would probably be in the right.

Dufour, in his monograph of the Algerian species (*Mem. p. à l'Institut de France*, xvii.), after describing a serious case arising from a Galeodes bite, having failed to find any poison-glands or apparatus, leaves the mystery to be solved by others.

Croneberg (*Zool. Anzeiger*, 1879) claimed to have discovered the poison gland in a long coiled gland, which he says opens at the tip of a lancet-shaped process at the junction of the palp with its basal or maxillar portion. As far as I can make out, this gland is the homologue of the coxal gland of the other Arachnids. This would not preclude the possibility of its being a poison gland. On the face of it, however, I should not expect to find the opening of the poison gland in this comparatively awkward place. In a creature so armed for attack as Galeodes, one would expect the venom to take a more prominent place in the offensive armoury.

Examination, on immersion in clearing media, shows—

(1) That the tips of the jaws are not only traversed by a canal opening to the exterior, but are covered with multitudes of fine pores, which can be traced with a low power through the thick chitin.

(2) The claws are also open at the tip, while the shaft of the claw seems filled with a glandular mass of tissue provided with tracheæ. These claws are terrible weapons of offence; the articulating joint at the end enables them to anchor themselves in the body of the prey.

(3) Around these claws are sharp hairs, which appear, like the claws, to be open at their tips. It is obvious that the tighter the claws draw themselves into the flesh, the deeper would the pointed hairs at their base penetrate, and, if poisonous, increase the deadly nature of the attack.

(4) Leaving the spines on the limbs, and the long, thin apparently tactile hairs out of account, the hairs on the legs and back are, as a rule, forked at the tip, as has been already described by Dufour. Up to the fork they are hollow, like those round the claws. My suggestion is that these are like buttoned rapiers. They are harmless until the animal is seized. The fork prevents the hair from penetrating until the pressure is great enough to snap off the tip. Small mammals and birds would soon learn not to try to chew up or swallow a Galeodes. If this suggestion is correct, the action of the forked hairs may be compared with that of the stinging hairs of the common nettle.

(5) Here and there are long hollow hairs, with the tips swollen out into a thin bubble-like expansion of the chitin. These hairs may be abnormal. I found five or six in all, and chiefly on the palp. They seem to indicate a tendency of fluid to flow down the hairs.

The openings at the tips of the claws are quite in keeping, morphologically, with those at the tips of the hairs. Claws are but highly developed hairs. The jaws, however, are modified joints of limbs. We have, therefore, to interpret the central canal (?) and the pores which open at and around their tips, as the canals which run through the cuticle into the hairs. We find that, as we recede from the tips of the jaws, the open pores cease, and the hairs commence, each with its central canal continued through the cuticle.

As to the nature of the poison which I suggest flows through these apertures, I am inclined to consider it, in the presumed absence of specialized glands, as a product of the hypodermal cells, perhaps even of those which secrete the hairs themselves. At the tips of the jaws, where the hairs have disappeared and only their pores remain, these cells could be specialized for this purpose alone. In the claws there seems to be a mass of cellular tissue, which would also be a derivative of the hypodermis, and may be solely taken up with the secretion of poison.

One other point remains to be mentioned, viz. the mechanism for the movement of the end joint of the claw. Articulated hairs are common among the Polychæte Annelids, but the exact mechanism is not visible. This large claw of Galeodes may explain these cases. We should naturally not expect a muscle fibre in a hair. The actual mechanism is very simple. Along one side of the claw the chitin splits, for, say, three-fourths of its proximal length, to form an inner and an outer layer. A very slight differentiation of the flexor muscles of the claw would allow of a few fibres being attached to the inner layer. A pull at the inner strip of chitin bends round the tip of the claw, invaginating a small portion of the outer layer, which thus forms a collar round the base of the joint or "nail" as some call it. The bending of the claw would almost necessarily compress its fluid contents, some of which might escape through the opening at its tip.

Until the question as to the poisonous nature of Galeodes has been *experimentally* settled, these observations seem to have some weight in the affirmative scale.

HENRY BERNARD.

Streatham.

Death from Paraffin, and Members of Parliament.

NOTWITHSTANDING the enormous development which has taken place in recent years in gas and electricity, there can be no doubt that oil lamps light the homes of a larger number of persons *throughout the world* than any other illuminant. Even in the United Kingdom alone it has been estimated that over 10,000,000 lamps are in use. No wonder, then, that newspaper readers are every now and again startled by the recital of terrible accidents, too often resulting in agonizing death. Mr. Alfred Spencer, of the London County Council, stated at the inquest on the late Lord Romilly that he estimated that there were 300 deaths a year caused in this country by unsafe lamps. Mr. Shean, of the Fire Brigade Association, expressed the opinion that 10 per cent. of fires are caused by paraffin lamps; and Captain Shaw, the former Superintendent of the London Fire Brigade, reported 156 fires in one year caused by the upsetting of lamps in London. Will a friend to humanity in each constituency ask the candidates, whether Liberal or Conservative, to pledge themselves to support a short Act of Parliament compelling every lamp to have affixed to it an automatic extinguisher, as recommended in the reports of Sir Frederick Abel, Mr. Boverton Redwood, and Colonel Majendie, or must we wait until a Bishop or a Royal Princess is burnt to death?

HUMANITY.

ON THE CAUSES OF THE DEFORMATION OF THE EARTH'S CRUST.

Mountain-making.

BY eminent geologists it has been shown that the contraction hypothesis is not sufficient to account for the observed deformations of the earth's crust. We are obliged to look for other causes of deformation.

The form of a cosmic body must be irregular if the masses are unequally mixed. Already in the liquid stage under this condition a geoid is formed. The radius with dense material must be shorter, so much as to equilibrate the higher regions with less density.

This cause of constant irregularity is not sufficient to explain the existing differences of level. In fact, depressions and elevations are not the result of a constant equilibrium; they are not permanent. Sedimentation and erosion disturb the mechanical and the thermal equilibrium and cause a continual deformation of our planet. Another cause of deformation is found in the continual shifting of material. Accumulation of eruptive material and of sediments (loading) on one side, and erosion (disburdening) on the other side, cause deformations of the earth's crust. If the plasticity of the cosmic body is great, the surface of the burdened and disburdened regions has the tendency to remain nearly level—a quasi-hydrostatic (a "magmastatic") equilibrium will dominate.

As the material of our earth is not very plastic, and as other causes of deformation have a contrary effect, it is natural that geological facts are not in accordance with this hypothesis.

Contradictory to this hypothesis are the facts (1) that subsidence does not continue as long as sedimentation goes on; (2) that sinking often is considerable, though the loading is slight; (3) that in many cases enormous loading does not produce a depression of the earth's crust (volcanic chains growing up on a highland).

The Thermal Theory.

The constant disturbance of thermal equilibrium is of the highest importance. Sedimentation causes an ascending movement of the geo-isotherms: expansion and general elevation. If the dilatation is concentrated, there may result a fold-chain (Hall, Reade). The hypothesis is supported by the fact that the elevation and folding always drives up sediments, which were formed immediately before the orogonic movement. The mountains grow up from a shallow sea, they are never generated in the middle of a continent, which might as well occur according to the contraction-hypothesis.

Messrs. Fisher, Hutton, and Reade have considered the thermal effect, and agree that it is sufficient to produce considerable deformations. But to produce a mountain-chain of some 1000 m., we must suppose a concentration of the effect in one zone, as long as we, according to Mr. Reade, consider only the effect of thermal expansion in the earth's crust.

As physical geology considers the earth as a rigid body (the plasticity, according to Mr. G. Darwin, being that of steel) there is no reason why the thermal expansion ought not to proceed through the rigid magma to the region of constant temperature. The increase of temperature being 3° C. for 100 m., the temperature at the depth of 40 km. = 1200° C., at 50 km. = 1500° C. After sedimentation of 10 km. the base of the sediments is warmer by 300°. The underlying masses are equally warmer by this quantity.

The linear expansion of rocks per 100° C. is nearly = 1 per mille, *i.e.* 1 metre per km. In our case the expansion is = 3 m. per km. Lateral expansion being impossible, it results in a vertical elevation of nearly 1 per cent. The *crust* would be elevated through the full expansion by 500 metres.

If we consider the thermal expansion proceeding to a depth of 500 or 1000 km. through the rigid magma, we find that indeed highlands and chains of some 1000 m. may be driven up, even if we do not suppose a concentration of the thermal effect on a restricted zone.

Yet certain facts are not in accordance with the theory thus formulated. (1) Elevation and mountain-making is not a slow and constant process, but it is executed in a short time (relatively). (2) Folding in some cases does not reach to a considerable depth, but we often meet undisturbed masses below the folded complex. These facts induce us to modify the hypothesis.

Messrs. Gilbert and Suess have shown that the movement of folding is horizontal and superficial; we may consequently ask whether folding may not be caused by a *gliding* movement (see my "Theoretical Geology").

If we deposit under water sediments of great plasticity, and if we incline afterwards the masses to the extent of 5° or 10°, there succeeds a gliding movement, especially if the sediments partly emerge from the water-level, and if occasional shaking (earthquakes) occurs.

The gliding masses form a fold-chain. The Silurian of Christiania is intensely folded, but it rests on an undisturbed base (Brögger). The folded Jurassic strata of the Weser chain likewise repose on an unfolded base. In such cases it is impossible to derive folding from a general contraction, nor can we explain the quiet base by supposing a concentration of thermal expansion in certain districts. The existence of a quiet base is explained only if we admit folding to be in such cases a gliding process.

The fact that folding in nature is accompanied by emersion is in accordance with these views.

Contradictory to this hypothesis seems the fact that the hypothetical land (from which the folded sediments were pushed towards the lowland) in the back of the chain is often wanting, and that in its place a (marine or a terrestrial) depression exists. This objection disappears if we pursue the process, and we find that this seemingly contradictory fact indeed must result: partial cooling causes local depression. Erosion has the same effect. If 1 km. (vertical measure) of rock mass is denuded, the temperature of the new surface is lower by 30° C. than it was at this point before erosion occurred. This cooling propagates into depth, and the denuded land gets depressed.

The highland, from which the sediments glide away, must sink down in course of time. The Jura is pushed towards the French plain; in the back is situated the depression of Neuchatel. Here, according to the deduction, existed a highland, which subsided in consequence of cooling. Between the fold-chain and the depressed district are situated deep ruptures, along which earthquakes occur as long as the depression goes on.

East of the Appalachian Mountains, as late as the end of the Palæozoic era, a highland was situated, wherefrom the detritus-masses were transported into the Appalachian sea. Afterwards the Carboniferous emersion occurred (in consequence of thermal expansion) and the Palæozoic sediments were pushed towards the western lowland; here the Appalachian chain was generated. Erosion and consequent cooling, instead of the old elevation, caused a depression in the eastern region, which got inundated by the ocean.

In course of time the adjoining districts have changed parts. In the lowland a chain is driven up and the old highland sinks down.

Eruptive districts form depressions with growing accumulations. The thermal effect in course of time leads to an opposite movement. Material of 1000° C. flows through many fissures and covers the surface. The eruptive region, in consequence, gets heated in a higher degree than by simple sedimentation. The period of depression in this case, too, in course of time, gives way to a contrary movement.

It is obvious that elevation and subsidence, in volcanic as well as in sedimentary districts, must alternate, as we indeed observe. Compression, metamorphism, and loading cause a negative movement in the sedimentary districts (geosyncline); warming causes elevation; erosion again creates subsidence. These positive and negative factors at different times have different values, and partly compensate each other. Therefore elevation and subsidence are often observed to alternate.

The greatest contrasts must occur where a highland joins the sea; here sedimentation and erosion cause a considerable shifting of material; loading and unloading, as well as great thermal contrasts, dominate in these regions.

The positive and negative movements of the sea-level are not important; but the amplitude of deformation at the boundary between high land and sea is in some cases as great as 20,000 metres.

The hydrosphere is relatively constant, whereas the crust executes oscillations of long duration and great amplitude.

If we want to study in an experiment the formation and motion of a lava-stream, it cannot be our wish to observe the motions of an enormous quantity of a body as viscid and as hot as lava through long time; that would be mere observation, and not experiment. In a real experiment we observe the motion of a small quantity of a less rigid material for some hours or days.

If we observe in nature folded strata of hard sandstone and of soft shale or clay, we shall be satisfied to imitate the deformation of the latter masses; and instead of the hard sandstone, we will take substances as unplastic, but so brittle that they yield to the small forces employed in our experiment.

So we may produce on a small scale, with application of little force and in a short time, the same effect which we observe in nature on a large scale.

If we succeed in producing experimentally the same phases of deformation, the same mechanical effect as in nature, if we see fold-chains and complicated eruptive massives growing up with their characteristic features, we shall be obliged to attribute to these experiments a high importance for mechanical geology.

In my experiments I evaporated muddy material (clay, mud) or plaster of Paris, which consolidates slowly in consequence of an admixture of glue. The strata were differently coloured: some thin strata, consisting of plaster-powder, were brittle, and underwent ruptural deformation, whereas the other masses showed plastic deformation. The whole system reposed on a base, which, according to the plasticity of the material, was inclined by 5° to 15°.

As soon as the inclination attained a certain limit, the whole complex begins to glide towards the lowland. The sediments get folded to a considerable depth; faults occurred between districts of diverse motion. The gliding deformation occurred rapidly whenever the base was shaken slightly (earthquakes). The experiment being finished, we let the masses consolidate; afterwards we may prepare profile-cuts, which may be executed with the saw, if we evaporated plaster.

The cuts are instructive, if the strata are differently coloured.

If we mark certain points in the originally level strata, or if we divide the whole system into cubes, we may study the locomotion and deformation of every point, line, square, or cube of our system; the vertical, as well as the horizontal component of displacement, may be observed and measured.

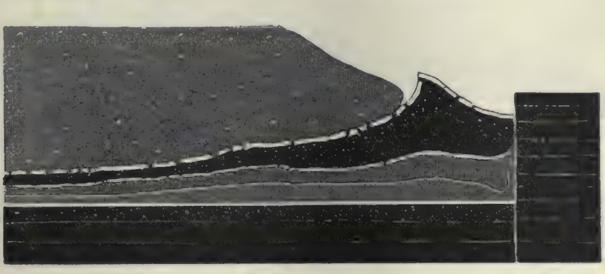


FIG. 1.

The following experiments explain some points in th theoretical essay:—

The plastic sediments are loaded by a mass, and get deformed in the manner illustrated by Fig. 1. The black base and the black side-wall at the right hand (fault scarp) are rigid; the plastic strata are pushed up in form of a fold; the highest white stratum is rigid, and gets torn into clods.

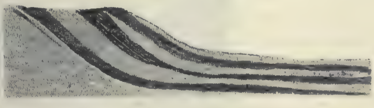


FIG. 2.

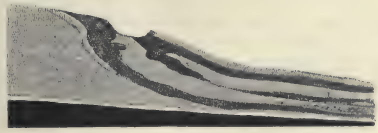


FIG. 3.

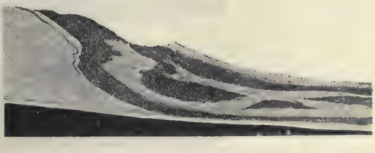


FIG. 4.

Figs. 2–4 show successive stages. A delta, deposited under water, gets elevated, it emerges; the masses are shaken slightly and glide over the inclined base. Folding succeeds, as Figs. 3 and 4 show.

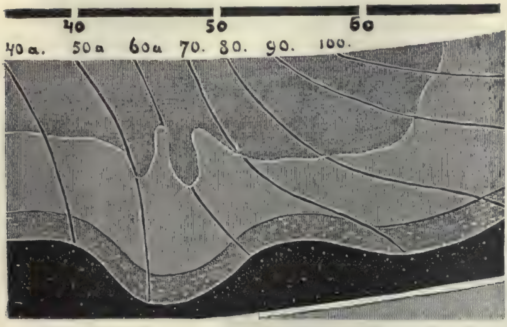


Fig. 5.

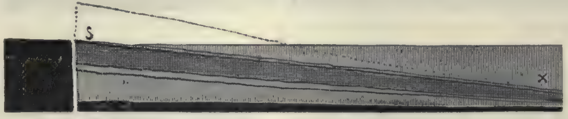
In Fig. 5 the strata, gliding over the inclined plane to the left, were divided by vertical lines. Distance of lines = 0·1 metre. At the top of the figure the fixed scale is noted. Point 40*a* of the strata originally lay directly below the scale-point 40, 60*a* was placed below 60, and so on.

We see at once the amount of horizontal (gliding) movement. The vertical lines are deformed in the direction of the motion. The parts near the base move little, the parts near the surface have a higher velocity, so that the vertical lines of division get curved. The motion being intense in the highland (at the right hand), the vertical lines in this region are pushed over and assume a flat position.

The surface of the gliding masses in this case remained level, as the material was very plastic; yet folding in the depth of the masses is remarkable. We see that a fold chain may have a wide surface; the intensely folded regions get exposed only after an extensive erosion or abrasion occurred. This experiment shows also how the motion and the amount of folding decrease in the direction towards the base.

Figs. 6 and 7 illustrate my conception of the process of glide-folding as it occurs in nature. The black parts form the solid basement; at S we observe a fault scarp (the coast of a continent). In the sea the sediments SX are deposited. Warming of the newly-deposited masses, and of the lower parts of the earth's crust, in course of time elevates the sediments, as the dotted line in Fig. 6 notes. The sediments glide over the inclined plane towards the right, and form a fold-chain, O.

The motion of a single point is noted in Fig. 8. Point S first gets elevated (through thermal intumescence) to S', and then it glides towards S''. In most cases the way described by a point is complicated, as Fig. 9 illustrates. Elevation having reached a certain degree, the masses glide a little, elevation continues, again gliding succeeds, and so on.



ig. 6.

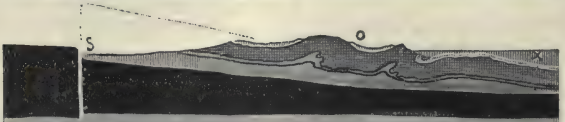


Fig. 7.

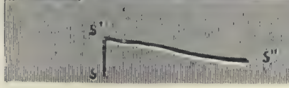


Fig. 8.

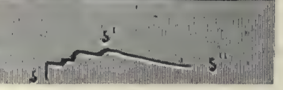


Fig. 9.

The highland in the back of the fold-chain (black mass at the left hand) gets eroded; cooling causes a subsidence of this region, the earth's crust breaks, and through the fissures and faults, in many cases, eruptive material escapes. A volcanic chain is built up in the back of the fold-chain (Fig. 10). In course of time the fold-chain

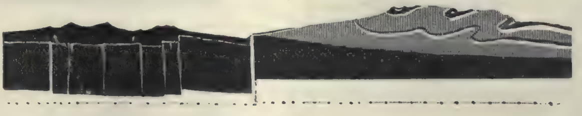


Fig. 10.

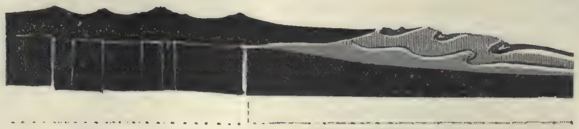


Fig. 11.

may be covered partly by the volcanic chain (Fig. 11). Fig. 12 (profile), and Fig. 13 (surface of the same experiment) show that pulling (tearing) and pushing (folding) are *reciprocal processes*. The strata, gliding away from the highland, are torn in this district, whereas compression and folding occur in the lowland.

The surface of the strata (Fig. 13) was divided into squares of different colour (like a chess-board), so that we may see and measure directly the direction and amount of pushing and pulling in both districts. Black fissures occur at the left hand, grey folds at the right hand.

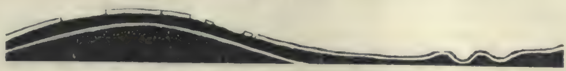


FIG. 12.

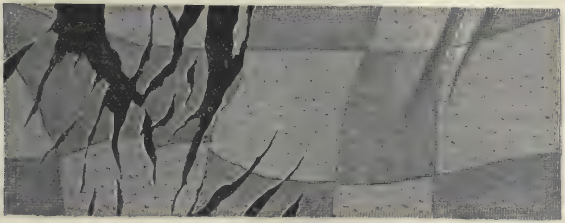


FIG. 13.

The base in this, as in the other cases, was rigid; there occurred *no compression in the depth*, yet folding succeeded in the gliding strata.

Folding, according to my opinion, does not depend on a contraction of our planet, but is a simple gliding phenomenon.

E. REYER.

NOTES.

AT the meeting of Section A of the British Association on Monday, August 8, there will be a discussion on the subject of a National Physical Laboratory. The discussion will be opened by Prof. Oliver J. Lodge, F.R.S.

THE Academy of Sciences at Berlin has conferred upon Lord Kelvin one of the first four Helmholtz gold medals.

THE French Association for the Advancement of Science will hold its twenty-first meeting at Pau from September 15 to 22.

THE Council of University College have accepted a tender for the erection of new technical laboratories for the practical teaching of mechanical and electrical engineering. Care has been taken that the buildings shall accord with all the conditions of modern teaching, but of course it is necessary that provision shall also be made for an adequate supply of apparatus and plant. The part of the proposed laboratory which is to be set apart for electrical engineering cannot be properly fitted up for a sum of less than £2010, and Prof. Fleming has issued an appeal to all who may be able and willing to help him in obtaining this amount. In the course of his appeal he says: "The Council do not at present see their way to incur this additional expenditure over and above the cost of the buildings, and yet it is absolutely essential to the completion of the project. The Council have, therefore, by a minute of their proceedings of May 7, 1892, recommended this very essential part of the proposed work to the notice and liberality of those who may be disposed to help. Thus sanctioned and authorized by the Council, the Professor of Electrical Engineering begs permission to bring under your notice the necessity for a special Electrical Apparatus Fund, and desires to invite your aid in the formation of such a fund of £2010, to be entitled 'The University College Electrical Engineering Apparatus Fund.'" Prof. Fleming is anxious that the sum should, if possible, be obtained within the next six months. Donations should be sent to the Secretary of University College, marked "Electrical Apparatus Fund."

THE services rendered by the late Sir William Macleay to the Linnean Society of New South Wales and to science in general are to be commemorated by the publication of a memorial volume. This was decided recently at a general meeting of the New South Wales Linnean Society. It is proposed that, in addition to a portrait and memoir of Sir William Macleay, the volume shall consist of original papers on those branches of science in the advancement of which he was especially interested—zoology, ethnology, botany, and geology. Promises of papers have already been received from Sir F. von Mueller, Prof. Hutton, Prof. J. Parker, Prof. Baldwin Spencer, and other leading Australian biologists. It is intended that, as regards "style of get up and illustration," the volume shall be fully worthy of the occasion. The expense is to be met by means of a public subscription. Every ordinary member of the Society subscribing one guinea or upwards, and any non-member subscribing two guineas or upwards, to the memorial will receive a copy of the volume. At the meeting of the Society on May 25, the President announced that a number of subscriptions had been received in answer to a circular issued a few weeks previously. It was necessary, however, he said, that a considerably larger sum should be collected before the Council would be in a position to proceed with the work.

THE Governors of the Merchant Venturers' School, Bristol, have elected to the vacant Lectureship in Biology Mr. G. P. Darnell-Smith, B.Sc., assistant to Dr. W. Marcet at University College, London. Mr. Smith is a student of University College, and graduated with honours in botany and zoology in 1891.

THE thunderstorms which we referred to in our last issue gave a very decided, but temporary, check to the temperature, the highest day readings falling about 20° after the storm; and the heavy rains which accompanied the disturbed weather have materially lessened the deficiency of rainfall, which has been so characteristic a feature for some months past. By the end of last week the temperature had recovered, and the weather became very fine in the southern parts of the kingdom, the maxima reaching from 80° to 85° at some inland stations on Sunday; while conditions remained unsettled, with heavy rain, in the north and west, owing to a cyclonic area which passed along the Irish coast, and caused a thunderstorm on the east coast. During the last day or two, depressions have passed to the northward of our islands, again causing unsettled weather, with rain in most parts; while the westerly winds have increased considerably in strength, reaching the force of a gale on our north-west coasts.

The *Weekly Weather Report* issued on the 2nd instant shows that the rainfall differed very considerably in various parts; in most of England, the north and west of Scotland, and in Ireland, the amount exceeded the mean. The greatest deficiency on the amount due from the beginning of the year is over the midland, south, and south-west of England, and the west of Scotland, the amounts varying from about 3 to 7 inches. Bright sunshine exceeded the average amount for the week, except in the north-western and south-western districts.

The Washington Weather Bureau has recently issued a report on its work for the last six months of the year 1891, dealing more with the scientific and practical work of the Department than with the administrative duties, which were referred to in a special report issued in October last (Nature, vol. xlv. p. 86). Prof. Harrington states that an endeavour has been made to improve the weather forecasts in every possible way; the time covered by the forecasts has been extended to thirty-six hours, and longer in some cases. Every effort is made to distribute the information as widely as possible, and for this purpose the telephone is becoming more popular, and will possibly eventually supersede the telegraph. Increased interest has of late been manifested in regard to meteorological education in the United States, and a list is given of the institutions which announce definite courses of instruction. A very large accumulation of data is now in the possession of the Weather Bureau; a summary of these, under each element, is given in the report, and it is proposed to utilize the materials by special studies to be undertaken by the officers of the Bureau. The study of terrestrial magnetism in connection with meteorology, with the object of discovering some physical relations connecting them, has from time to time been made by various persons, but, on the whole, it has not led to definite results. Prof. Harrington states, however, that the subject is now being specially investigated by Prof. F. H. Bigelow, one of the meteorologists of the Bureau, and that such progress has been made as to render it quite certain that they are intimately associated. By the method of analysis now being used by Prof. Bigelow, which differs from that hitherto employed, it is stated that he has been able to disentangle several of the magnetic fields surrounding the earth, which are observed in the magnetic curves as an integrated effect.

According to the *Pioneer Mail*, the Port Officer of Mangalore reports that a native craft was overtaken by heavy weather and made for Mangalore, where there is a bad bar with about eight feet of water in it. A tremendous sea was breaking over the bar, so, before crossing it, and while running in, the native skipper opened one oil cask, forming a part of the cargo, and scattered it all round in the sea plentifully, with the result that he took his craft across the bar safely, and so saved the vessel and the cargo. The vessel's name was *Mahadeprasad*, and she was of 95 tons, bound from Cochin to Bombay. This is said to be the first case on record of a native tindal who has successfully used the oil in troubled waters.

Mr. H. Rowland-Brown, writing in the current number of the *Entomologist*, says that when sitting in the Temple Gardens on June 22 he saw a fine male *Colias edusa* fly across the lawn. The excitement among the sparrows was "simply immense," but the butterfly "proved a match for his innumerable pursuers, and sailed calmly over the railings towards the City." The editor of the *Entomologist* adds a note to the effect that this species was seen in London in 1877, which is remembered as the great "*edusa* year."

A fact noted in the current number of the *Zoologist* gives a very vivid idea of the depth of snow and drift in the north of Scotland last winter. In the parish of Lairg, a month or two after the first thaw set in, two full-grown stags were found dead in a hollow in a "burn." The first thing one of the keepers saw was a stag's antlers above the snow. These he took for the branch of a tree, but on going near he found that a stag had been smothered by the drifting snow while standing on its feet. A week or so afterwards, when more of the snow was melted, another stag was discovered. This one had been smothered while lying down. He was close to his comrade.

The Peabody Museum has issued, in its series of archæological and ethnological papers, an interesting report on pile-structures in Naaman's Creek, near Claymont, Delaware, by Dr. H. T. Cresson. These pile-structures are believed to be remains of prehistoric fish-weirs.

The Chicago Exhibition will include what promises to be a very important department for the exhibition of objects relating to ethnology, archæology, history, and cartography. A special bureau connected with the department will represent the history of the Latin-American Republics, and include all relics of the time of Columbus. There will also be a group of "isolated and collective exhibits." A full account of the plan of the department, and of the classification of the exhibits, has been prepared by Mr. F. W. Putnam, chief of the department. By means of special research in different parts of America, under Mr. Putnam's direction, important scientific collections in the ethnological and archæological sections will be brought together. It is hoped that every State Board and many historical and scientific Societies, as well as owners of private collections, will do what they can to contribute to the success of the department, so that it may present a full and effective illustration of the present status of American archæology and ethnology.

Messrs. Mitchell and Hughes have issued the Transactions of the County of Middlesex Natural History and Science Society for the sessions 1889–90 and 1890–91. The volume contains papers on rabies—its natural history and the means of extinguishing it, by Arthur Nicols; the best means of examining Rotifers under the microscope, by C. Rousselet; the tubercle bacillus, by A. W. Williams; and "A Night among the Infinities," with a description of the instruments at Stanmore Observatory, by Sydney T. Klein.

The July number of *Natural Science* opens with some "Notes and Comments," and contains articles on "The Story of Olenellus," by Prof. G. A. J. Cole; the physical features of the Norfolk Broads, by J. W. Gregory; the evolution of flat-fish, by Prof. A. Giard; is Stigmaria a root or a rhizome? by T. Hick (with "A Reply," by Prof. W. C. Williamson, F.R.S., and "A Rejoinder," by T. Hick); agricultural museums, by J. H. Crawford; and amber and fossil plants, by A. C. Seward.

A paper on three deep wells in Manitoba, by Mr. J. B. Tyrrell, was lately submitted to the Royal Society of Canada, and has now been printed in the Transactions. It contains a good deal of interesting and well arranged geological information.

Mr. D. J. Macgowan, writing in the *Shanghai Mercury*, gives an account of some remarkable statements made by a group of Chinese traders who lately undertook a mercantile exploration of the interior of Southern Formosa. They started from Lamalan, which Mr. Macgowan takes to be Chockeday of the charts, and in seven days reached their objective point, Hualin Stream. They lodged in stone caverns, and the chattering of monkeys and the sounds of insects seemed to them "appalling and indescribable." The region was so "weird" that it reminded them of "legends of the kingdom of hobgoblins." Among the trees were some of "prodigious girth, forming a vast forest." These trees are said to measure more than ten outstretched arms. A tree said to flourish in the same forest is described as bearing "flowers, red and white, which are larger than a sieve, and of extraordinary fragrance." Mr. Macgowan adds:—"Mr. Taylor, while searching for orchids, heard of these majestic trees and huge flowers, which he inferred, from what natives said, were epiphyte orchids. I am moved to make known this sylvan discovery in the hope that, pending the exploration of this *terra incognita* by our botanists, Dr. Henry or Mr. Ford, residents in Formosa, will take measures to provide those naturalists with specimens of flowers, seeds, leaves, and bark of the trees concerning which the Chinese have excited our curiosity."

IN a capital address on "tooth culture," delivered at the annual meeting of the Eastern Counties Branch of the British Dental Association, and printed in the current number of the *Lancet*, Sir James Crichton-Browne referred to a change which has taken place in bread, as one of the causes of the increase of dental caries. So far as our own country is concerned, this is essentially an age of white bread and fine flour, and it is an age therefore in which we are no longer partaking, to anything like the same amount that our ancestors did, of the bran or husky parts of wheat, and so are deprived to a large degree of a chemical element which they contain—namely, fluorine. The late Dr. George Wilson showed that fluorine is more widely distributed in nature than was before his time supposed, but still, as he pointed out, it is but sparingly present where it does occur, and the only channels by which it can apparently find its way into the animal economy are through the siliceous stems of grasses and the outer husks of grain, in which it exists in comparative abundance. Analysis has proved that the enamel of the teeth contains more fluorine, in the form of fluoride of calcium, than any other part of the body, and fluorine might, indeed, be regarded as the characteristic chemical constituent of this structure, the hardest of all animal tissue, and containing 95·5 per per cent. of salts, against 72 per cent. in the dentine. As this is so, it is clear that a supply of fluorine, while the development of the teeth is proceeding, is essential to the proper formation of the enamel, and that any deficiency in this respect must result in thin and inferior enamel. Sir James Crichton-Browne thinks it well worthy of consideration whether the reintroduction into our diet of a supply of fluorine in some suitable natural form—and what form, he asks, can be more suitable than that in which it exists in the pellicles of our grain stuffs?—might not do something to fortify the teeth of the next generation.

THE recent publication is announced of the first number of a new monthly journal under the title *Rivista di patologia vegetale*. It is edited by Sigg. A. N. and A. Berlese, and published at Avellino, in Italy; and is to be devoted to the study of animal and vegetable parasites infesting cultivated plants, to the diseases which they cause, and the remedies employed to combat them.

DR. H. C. CHAPMAN contributes to the latest instalment of the Proceedings of the Academy of Natural Sciences, Philadelphia, a paper describing observations on the brain of the gorilla. He says that while the fissures and convolutions are disposed in the brain of the gorilla in the same manner, generally speaking, as in that of man or of the chimpanzee or orang, it is nevertheless a low type of brain, being much less convoluted than the brain of man or of either of the two other anthropoids. If it were permissible, in the absence of living links or sufficient fossil remains, to speculate upon the development of man and the anthropoids from lower forms of simian life, Dr. Chapman thinks it might be inferred from the character of the brain that the gorilla had descended from some extinct *Cynocephalus*; the chimpanzee and orang from extinct macaque and gibbon-like forms; and man from some generalized simian form combining in itself the characteristics of existing anthropoids.

AT the annual meeting of the Department of Electricity of the Brooklyn Institute of Arts and Sciences on June 1, Prof. E. J. Houston delivered a lecture on recent advances in the applications of electricity. Turning for a moment from the past to the future, Prof. Houston said it was related of Faraday that when asked his opinion of the future of the electric motor, he put up his cane and stopped it. That was Faraday's opinion. Prof. Houston's view was more favourable. The true efficiency of a triple expansion steam engine, he said, did not exceed 17 per cent. as a maximum. With the electric motor we could already get an efficiency of from 90 to 95 per cent., but it was to-day dependent on the steam-engine. A cheaper method would be devised for generating currents, and he believed there were now those living who would see the steam-engine relegated to the scrap heap. Possibly the motor of the future would be operated by thermo-electricity. Possibly a means would be devised of converting the latent energy of coal directly into potential electrical energy. He believed in the successful solution of the problem of aërial navigation in the near future. He was confident that ere long our present methods of electric illumination, in which 97 to 98 per cent. of the energy was expended in useless heat rays, would be supplanted by one in which the order was reversed—in which 97 to 98 per cent. would be converted into light, and but 2 to 3 into heat. And finally, he believed the time was near at hand when electro-therapeutists, instead of regarding the human body as a vehicle for electricity, would regard it as a source of electricity. They would then make their diagnoses with the voltmeter, the ammeter, and the condenser, and the result would then be definite, instead of, as at present, "hit or miss."

THE *Mediterranean Naturalist* quotes a statement made by the late Rev. H. Seddall, who was many years a resident of Malta, as to a curious form of industry formerly practised by the Maltese. "Five species of *Pinna*," wrote Mr. Seddall, "are found in Malta, some of them common in the harbours within reach of a boat or a pole hook. They project from the mud amongst the Zostera roots, to which they are attached by their silken cable. Of this silk, which is of fine texture, but heavy, I have seen gloves made."

THE additions to the Zoological Society's Gardens during the past week include a Palm Squirrel (*Sciurus palmarum*) from India, presented by Miss Daisy Fox; a Common Roe (*Capreolus capræa* ♂), European, presented by Mr. E. J. H. Towers; a Tawny Owl (*Syrnium aluco*), European, presented by Mr. Leigh Robinson; a Bronze Fruit Pigeon (*Carpophaga ænea*) from India, presented by Mr. J. L. Shand; a Tuberculated Tortoise (*Homopus femoralis*), a Tent Tortoise (*Testudo tentoria*), two Fisk's Tortoises (*Testudo fiski*), a Robben Island Snake (*Coronella phocarum*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; two Green Lizards (*Lacerta viridis*), European, three Viperine Snakes (*Tropidonotus viperinus*) from North Africa, presented by the Rev. F. M. Haines; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. Samuel L. Bensusan; a Water Viper (*Cenchris piscivora*) from North America, presented by Mr. Ernest Brewerton; a —— Zorilla (*Zorilla typica*), a Grey Monitor (*Varanus griseus*) from Egypt, a Stanley Parrakeet (*Platycercus icterotis*) from Australia, deposited; two Asiatic Wild Asses (*Equus onager* ♂ ♀) from South-west Asia, received in exchange; four Wapiti Deer (*Cervus canadensis* ♂ ♀ ♀ ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE RED SPOT ON JUPITER.—M. J. J. Landerer, in *Bulletin Astronomique* (tome ix., June), gives the results of his measurements of the dimensions and Jovicentric latitude of the red spot on Jupiter. The method he adopted was to make use of the transit of the satellite's shadows as they were projected on the extreme points of the two axes of the spot, the mean giving the position of the spot's centre. In the case of the third satellite, when its latitude was −1° 45′ 14″, that of its shadow—reckoning from the bottom side of the spot—was −30° 34′ 36″. The latitude of the shadow of the second satellite came out to be −17° 48′ 10″, and after allowing for the fact that it was projected tangentially on the side of the spot and for the diffraction of the instrument, this value for the latitude of the north side of the spot became −20° 56′ 37″. Taking the mean of the values obtained from both satellites, the latitude of the centre was −25° 45′ 36″, and, with the polar semi-diameter as unity, the magnitude of the spot was 0·20297.

The mean value of the latitude obtained from eleven observations by Denning, Green, Ricco, Williams, Keeler, and Terby was 21°·5 ± 2°·05, the major and minor axes of the spot being 0·555 and 0·188 respectively. Using the micrometer, the latitude, according to Young, amounted to 40°; while Denning estimated that the major axis embraced an arc varying between 29°·3 and 37°·8.

A Mean Time Sun-dial.—A very ingenious sun-dial, capable of indicating mean time, has been recently invented by Major-General Oliver, the construction of the instrument being undertaken by Messrs. Negretti and Zambra. In an ordinary sun-dial, the time is read off generally by the position of the centre of a shadow, cast by a straight-edged style, on a flat surface on which the hours are graduated. The peculiarity of the present instrument is that the time is indicated by the position of the *edge* of a shadow cast by a "nine-pin" shaped style, with regard to an equatorial circular line. The style is fixed along the diameter of a semicircular arc, which is clamped by means of a screw to a firm stand to suit any latitude; at right angles to this arc, and also capable of adjustment, is another semicircle, graduated in five-minute divisions. Owing to the change of declination of the sun throughout the year, different *parts* of the shadow of the style are brought on to the hour circle in such a way that the difference between the time indicated (by the dial) and mean time, or the equation of time, is counterbalanced by the change in position of the shadow, due to the peculiar form of the style. If we start, for instance, on December 24, the readings have to be taken from the shadow of the eastern edge of the lower part of the style in an upward direction, the bulging out of the style counteracting the increase and decrease of the equation of time (which is here positive) until June 14 is reached. Owing to the thickness of the style's axis, a slight adjustment is here necessary when we pass to the other side of the style; this adjustment is facilitated by placing the twelve o'clock graduation to the western of two marks shown on the vertical circle. This being done, the readings from the shadow, cast now by the western side of the upper protuberance, are taken until the other nodal point on June 14 is reached. At this time also—in fact, four times a year—this slight alteration has to be made. From this latter date until December 24 is reached the same process is repeated, only the respective opposite sides of the style are used in the inverse order. To obviate the necessity of having two styles, which, of course, would have to be the case if the greatest accuracy were desired, owing to the differences in the maximum values of the equation of time, one with a mean contour is given: the error produced by this is practically very slight, amounting in time to about one-sixteenth of greatest value of the equation of time—a quantity scarcely appreciable, on account of the lack of sharpness of the edge of the shadow.

Comet Swift (1892 March 6).—*Edinburgh Circular* No. 28 contains a continuation of the ephemeris of Comet Swift (March 6, 1892) for the month of July and part of August, from which we make the following extract:—

Berlin Midnight.

1892.	R.A.	Decl.	log Δ.	log *r*.	Br
	h. m. s	° ′			
July 7	0 52 36	+48 0·5			
8	53 33	12·6	0·2391	0·2552	0·17
9	54 28	24·5			
10	55 20	36·2			
11	56 10	47·7			
12	56 58	59·0	0·2427	0·2665	0·16
13	57 43	49 10·0			

The brightness at the time of discovery being taken as the unit of brightness, it will be seen that the comet is at present more than five times dimmer than it was in March. In fact, it is rapidly becoming invisible, and will only be able to be observed with large instruments for another two months or so. Its position on July 7 will lie to the very southern extremity of the constellation of Cassiopeia, forming nearly an equilateral triangle with ξ and π.

Stars' Proper Motions.—Mr. J. G. Porter contributes to the *Astronomical Journal*, No. 268, a catalogue of the proper motions of 301 stars, which amount to half a second or more in a year. This list, as he informs us, is from a still more extensive catalogue which he hopes soon to publish; and the proper motions contained in it are rendered more trustworthy by the enlightenment of new observations. The positions of the stars are all brought up to the epoch 1900·0.

GEOGRAPHICAL NOTES.

M. Charles Allnand describes his researches on the Island of Mahé, the largest of the Seychelles Group (see Nature, p. 162), in a letter to the Paris Geographical Society. He has studied the fauna with some care, and remarks on the singular poverty of animal life compared with the great luxuriance of vegetation. In Port Victoria, the chief settlement in Mahé, the only form of butcher-meat obtainable is the flesh of the great turtle (*Chelone midas*) whose shell is valueless, the tortoise-shell fisheries of the island depending on the *Chelone imbricata*. M. Allnand hopes to bring back with him living specimens of the elephantine turtles of the Aldabra Islands, specimens of which have been transported to the Seychelles.

The expectation of an Antarctic expedition, on which valuable scientific observations might have been made, has proved illusory. Captain Gray, of Peterhead, had organized a whaling voyage to the far south, and appealed to the public for funds to carry it out with some prospect of commercial success, but the response was so unsatisfactory that the enterprise has been abandoned. From a scientific point of view, the advantages of Antarctic exploration is so great, and the probability of valuable practical results so apparent, that the apathy alike of the British and Australian Governments as well as of the general geographical public is incomprehensible. The fact that no steamer has ever been despatched to the south of the Antarctic Circle with the object of attaining high latitudes says much for the prudence and little for the energy of present-day explorers.

A Chair of Colonial Geography is about to be established at the Sorbonne for the special study of the French colonies.

The discovery of America by Columbus is to be celebrated in Hamburg on October 11 and 12 by gatherings of delegates from the German Universities and Geographical Societies, by whom papers bearing on German enterprise in the sixteenth century will be read. An exhibition of articles illustrating the early connection of Hamburg and America will also be held.

The Manchester Geographical Society has just published its *Journal* for July–September 1891, containing several interesting papers on India and a variety of short notices. It is unfortunate that the small local encouragement given to this Society makes the earlier publication of its memoirs possible. Surely Manchester could afford and should endeavour to maintain a Geographical Society as prosperous financially as it is enterprising and persevering. The contrast between the many provincial Geographical Societies in Germany and France with the three already established in England corresponds to the relative interest in geography as an aid to commerce on the Continent and in Great Britain.

METALLIC CARBONYLS.[1]

Justus Liebig, perhaps the most prophetic mind among modern men of science, wrote in the year 1834 in the *Annalen der Pharmacie*. "I have previously announced that carbonic oxide may be considered as a radical, of which carbonic acid and oxalic acid are the oxides, and phosgene gas is the chloride. The further pursuit of this idea has led me to the most singular and the most remarkable results."

Liebig has not told us what these results were, and it has taken many years before the progress of chemical research has revealed to us what may at that early date have been before Liebig's vision. I will to-night bring before you some important discoveries made only within the last few years by following up Liebig's idea.

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[1] Friday Evening Discourse delivered at the Royal Institution by Ludwig Mond, F.R.S., on June 3.

Carbonic oxide, composed of one atom of carbon and one atom of oxygen, is a colourless gas, without taste or smell, which I have here in this jar. It burns with a blue flame. When it acts as a radical combining with other bodies, we term it carbonyl, and its compounds with other elements or radicals are termed carbonyls.

Liebig defined a radical as a compound having the characteristics of a simple body, which would combine with, replace, and be replaced by simple bodies. In more modern times a radical has been defined as an unsatiated body. I am of course speaking of chemical radicals. If we look at it from the modern point of view, carbonyl should be the very model of a radical, because only half of the four valencies of the carbon atom are satiated, the other two remaining free. Carbonic oxide should even be a most violent radical, because, amongst all organic radicals, it is the only one we know to exist in the atomic or free state. All the other organic radicals, even such typical ones as cyanogen and acetylene, are known to us as molecules composed of two atoms of the radical, so that the cyanogen gas and acetylene gas we know should more properly be called di-cyanogen and di-acetylene; they consist of two atoms of the radical cyanogen or of the radical acetylene, the free valencies or combining powers of which satiate or neutralize each other. On the other hand, carbonic oxide gas, as I stated before, makes the sole exception. Its molecule contains only one atom of carbonyl moving about with its free valencies unfettered by a second atom. For all that, carbonic oxide is by no means a violent body, but the very reverse, and instead of being ready to attack with its two free valencies anything coming in its way, until very recently we only knew it to interact and to combine with substances possessing themselves extreme attacking powers, such as chlorine and potassium. Although Liebig had so long ago proclaimed it as a radical, the chemical world was startled when, two years ago, I announced in a paper I communicated to the Chemical Society in conjunction with Drs. Langer and Quincke, that carbonic oxide combines at ordinary temperature with so inactive an element as nickel, and forms a well-defined compound of very peculiar properties.

The fact that carbonic oxide does not possess the chemical activity one would suppose in a radical composed of single atoms may, I believe, be explained by assuming that the two valencies of carbon which are not combined with oxygen do satiate or neutralize each other. Everybody admits that the valencies of two different carbon atoms, which are all considered of equal value, can neutralize each other. I see, therefore, no reason to question the possibility of two valencies of the same carbon atom neutralizing each other. On this assumption carbonic oxide may be looked upon as a self-satisfied body—one which keeps in check its free affinities within itself.

You have here the typical carbon radicals containing one atom of that element, acetylene, methylene, methyl, cyanogen, and carbonyl. In the second column you have these substances as they are known to us in the free state. You see the carbonyl is the only one which exists in the free state as a single atom, while all the others only exist as molecules, composed of two atoms the free valencies of which neutralize each other. The carbonyl I have represented in the last formula, with the two valencies not combined with oxygen neutralizing each other, so that in this way it also becomes a satiated body. I will try to make this still plainer to you by means of the models I have before me.

The paper published by Liebig in 1834, from which I have already quoted, was entitled "On the Action of Carbonic Oxide on Potassium." In it Liebig fully described the preparation and properties of the first metallic carbonyl known—a compound of potassium and carbonic oxide. Liebig obtained this compound by the direct action of carbonic oxide upon potassium at a temperature of 80° C., and proved it to be identical with a substance which had been previously obtained as a very disagreeable by-product of the manufacture of potassium from potash and carbon by Brunner's method. It forms a grey powder which is not volatile, and which on treatment with water yields a red solution, gradually turning yellow in contact with air, and from which on evaporation a yellow salt is obtained, called potassium croconate, on account of its colour. Liebig showed this salt to consist of two atoms of potassium, five of carbon, and five of oxygen, and not to contain any hydrogen, as had previously been supposed.

Since the publication of Liebig's paper, potassium carbonyl has been studied by numerous investigators, amongst whom Sir Benjamin Brodie deserves particular mention; but it has been reserved to Nietzki and Benkiser to determine finally in the year 1885, by a series of brilliant investigations, its exact constitution, and its place in the edifice of chemistry. They have proved that it has the formula $K_6C_6O_6$; that the six carbons in this compound are linked together in the form of a benzole ring; that, in fact, the compound is hexhydroxylbenzole, in which all the hydrogen is replaced by potassium. By simple treatment with an acid it can be converted into the hexhydroxylbenzole, and from this substance it is possible to produce, by a series of reactions well known to organic chemists, the whole wide range of the benzole compounds. The body which Liebig obtained by the direct action of carbonic oxide on potassium has thus enabled us to prepare synthetically in a very simple way from purely inorganic substances—to wit, from potash and carbon, or if we like even from potash and iron—the whole series of those most important and interesting compounds called aromatic compounds, including all the coal-tar colours, which have furnished us with an undreamt-of variety of innumerable hues and shades of colour, as well as many new substances of great value to suffering humanity as medicines. Surely a startling result, which alone would have fully justified Liebig's prediction of 1834!

Speaking of coal-tar colours, everybody will be reminded of the great loss the scientific world has recently sustained by the death of August Wilhelm Hofmann, their first discoverer, Liebig's greatest pupil. Hofmann will ever be remembered in this Institution, where he so often delighted the audience by his lucid lectures, and in whose welfare he took the greatest interest, of which he gave us a fresh proof only last year, in the charming letter he wrote on the occasion of his election as an honorary member.

Looking back upon the wonderful outcome of Liebig's idea I have referred to, it seems surprising indeed that others should not have followed up his work by attempting to obtain other metallic carbonyls.

A very few experiments were made with other alkaline metals: sodium, otherwise resembling potassium so closely, has been shown not to combine with carbonic oxide; lithium and cæsium are stated to behave similarly to potassium. But metals of other groups received little or no attention. The very important *rôle* which carbonic oxide plays in the manufacture of iron did lead a number of metallurgists (among whom Sir Lowthian Bell and Dr. Alder Wright are the most prominent) to study its action upon metallic iron and other heavy metals, including nickel and cobalt at high temperatures. They proved that these metals have the property to split up carbonic oxide into carbon and carbonic acid at a low red heat, a result of great importance, which threw a new light upon the chemistry of the blast furnace. None of these investigators, however, turned their attention to obtaining compounds of these metals with carbonic oxide, and, owing to the high temperature and the other conditions under which they worked, the existence of such compounds could not come under their observation. In order to obtain these compounds, very special conditions must be observed, which are fully described in the papers I have published during the last two years in conjunction with Dr. Langer and Dr. Quincke.

The metals must be prepared with great care, so as to obtain them in an extremely fine state of division, and must be treated with carbonic oxide at a *low temperature*. The best results are obtained when the oxalate of the metal is heated in a current of hydrogen at the lowest temperature at which its reduction to the metallic state is possible. I have in the tube before me metallic nickel prepared in this way, and over which a slow current of carbonic oxide is now passing; the carbonic oxide before entering the tube burns, as you see, with a blue non-luminous flame. After passing over the nickel it burns with a highly luminous flame, which is due to the separation of metallic nickel from the nickel carbonyl formed in the tube, which is heated to incandescence in the flame. (In passing the gas issuing from our tube through a glass tube heated to about 200°, we obtain a metallic mirror of pure nickel, because at this temperature the nickel carbonyl is again completely resolved into its components, nickel and carbonic oxide. If we pass the gas through a freezing mixture, you will observe that a colourless liquid is condensed, of which I have a larger quantity standing in this tube. This liquid formed is pure nickel carbonyl, and has the formula $Ni(CO)_4$.

If cooled to $-25°$ C., it solidifies, forming needle-shaped crystals. The vapour of nickel carbonyl possesses a characteristic odour and is poisonous, but not more so than carbonic oxide gas. Prof. McKendrick has studied the physiological action of this liquid, and has found that, when injected subcutaneously in extremely small doses in rabbits, it produces an extraordinary reduction in temperature, in some cases as much as 12°.

The liquid can be completely distilled without decomposition, but from its solution in liquids of a higher boiling-point it cannot be obtained by rectification. On heating such a solution the compound is decomposed, nickel being separated in the liquid, while carbonic oxide gas escapes. I will try to demonstrate this by an experiment.

We have here a solution of the substance in heavy petroleum oil, which you will, in a few minutes, see turns completely black on heating by the separation of nickel, while a gas escapes which is carbonic oxide.

In a similar way, when the nickel carbonyl is attacked by oxidizing agents, such as nitric acid, chlorine, or bromine, it is readily broken up, nickel salts being formed, and carbonic oxide being liberated. Sulphur acts in a similar way. Metals, even potassium, alkalies, and acids, which have no oxidizing power, will not act upon the liquid at all, nor do the salts of other metals react upon it. The substance behaves therefore, chemically, in an entirely different manner from potassium carbonyl, and does not lead, as the other does, by easy methods to complicated organic compounds. It does not show any one of the reactions which are so characteristic for organic bodies containing carbonyl, such as the ketones and quinones; and we have not been able, in spite of very numerous experiments, either to substitute the carbonic oxide in this compound by other bivalent groups, or to introduce the carbonic oxide by means of this compound into organic substances.

By exposing the liquid to atmospheric air, a precipitate of carbonate of nickel is slowly formed of varying composition, which is yellowish-white if perfectly dry air is used, and varies from a light green to a brownish colour if more or less moisture is present. We have found all these precipitates to dissolve easily and completely in dilute acid, with evolution of carbonic acid, leaving ordinary nickel salts behind, and can therefore not agree with the view propounded by Prof. Berthelot, in a communication to the French Academy of Sciences, that these precipitates contain a compound of nickel with carbon and oxygen, comparable to the so-called oxides of organo-metallic compounds. In the same paper Prof. Berthelot has described a beautiful reaction of nickel carbonyl with nitric oxide, which we will now show you. You will notice the intense blue coloration which the liquid solution of nickel carbonyl in alcohol assumes by passing the nitric oxide through it. Prof. Berthelot has reserved to himself the study of this interesting body, but has so far not published anything further about it.

The chemical properties of the compound I have just described to you are without parallel; we do not know a single substance of similar properties. It became, therefore, of special interest to study the physical properties of the compound.

Prof. Quincke, of Heidelberg, has kindly determined its magnetic properties, and found that it possesses in a high degree the property discovered by Faraday, and called by him diamagnetism, which is the more remarkable, as all the other nickel compounds are paramagnetic. He also found that it is an almost perfect non-conductor of electricity, in this respect differing from all other nickel compounds.

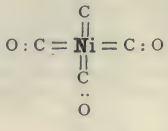
The absorption spectrum, and also the flame spectrum, of our compound are at present under investigation by those indefatigable spectroscopists, Profs. Dewar and Liveing, by whose kindness I am enabled to bring before you, in advance of a paper they are sending to the Royal Society, some of the interesting results they have obtained. We have here a photograph of the absorption spectrum, obtained by means of a hollow prism through quartz plates filled with nickel carbonyl, through which the spark spectrum of iron is passed, which is photographed on the same plate. You see that the whole of the ultra-violet rays of the iron spectrum have disappeared, being completely absorbed by the nickel carbonyl, which is thus quite opaque for all the rays beyond the wave-length 3820. The spectrum of the highly luminous flame of nickel carbonyl, which I have shown you before, is quite continuous; but if the nickel carbonyl is diluted with hydrogen, and the mixture burnt by means of oxygen, the gases burn with a bright yellowish-green flame without visible smoke; and the spectrum of this flame shows in its visible part, on a background of a continuous spectrum, a large number of bands, brightest in the green, but extending on the red side beyond the red line of lithium, and on the violet side well into the blue. These bands cannot be seen on the photograph which I will now show you, the visible part of the spectrum appearing continuous; but beyond the visible part the photograph shows a large number—over fifty—of well-defined lines in the ultra-violet. I will show you these lines in another photograph taken with greater dispersion, and on which has also been photographed the spark spectrum of nickel. You will see that all these lines correspond absolutely to lines appertaining to the spark spectrum; in fact, the greater part of the lines in the spark spectrum are also shown in this flame spectrum. We have here another and very striking example of the fact discovered on the same day by Profs. Dewar and Liveing, and by Dr. Huggins, that the spectrum of luminous flames is not always continuous throughout its whole range, a fact which was at one time much debated and discussed.

One of the most remarkable discoveries made within the precincts of this Institution by that illustrious man whose centenary we celebrated last year was that of the connection between magnetism and light, which manifests itself when a beam of polarized light is sent through a substance while it is subjected to a strong magnetic field, under whose influence the beam of light is rotated through a certain angle. Dr. W. H. Perkin has prosecuted this discovery of Faraday's by a long series of most elaborate researches, and has established the fact that this power of magnetic rotation of various bodies has a definite relation to their chemical constitution, and enables us to gain a better insight into the structure of chemical compounds. Dr. Perkin has been good enough to investigate the power of magnetic rotation of the nickel carbonyl, and has found it quite as unusual as its chemical properties, and to be, with the sole exception of phosphorus, greater than that of any other substance he has yet examined.

The power of different bodies of refracting and dispersing a ray of light has been shown by the beautiful and elaborate researches undertaken many years ago by Dr. Gladstone—who has given an account of them in this theatre in 1875, and who has since continued them with indefatigable zeal—to throw a considerable light upon the constitution of chemical compounds.

I have investigated the refractive and dispersive powers of nickel carbonyl in Rome, in conjunction with Prof. Nasini. We found that the atomic refraction of nickel in the substance is nearly two and a half times as large as it is in any other nickel compound—a difference very much greater than had ever before been observed in the atomic refraction of any element. To give you some idea how these figures are obtained, Mr. Lennox will now throw on to the screen a beam of light through two superposed prisms, one filled with nickel carbonyl and the other with alcohol. You will notice that the lines of the spectrum on the top are turned much further to the left, showing the nickel carbonyl to possess a much greater power of refraction than alcohol, and you will also notice that it is much wider than the bottom spectrum, which shows the greater dispersive power of the nickel carbonyl.

It is now generally supposed that, if one element shows different atomic refractive powers in different compounds, it enters with a larger number of valencies into the compound which shows a higher refractive power. In accordance with this view, the very much greater refractive power of the nickel in the carbonyl would find an explanation in assuming that this element, which in all its other known combinations is distinctly bivalent, exercises in the carbonyl the limit of its valency, viz. 8, assigned to it by Mendeleeff, who placed it in the eighth group in his Table of Elements. This would mean that the one atom of nickel contained in the nickel carbonyl is combined directly with each of the four bivalent atoms of carbonyl, each of which would saturate two of the eight valencies of nickel, as is shown by this formula—



$$\begin{array}{ccccc} & & \mathrm{O} & & \\ & & \cdot\cdot & & \\ & & \mathrm{C} & & \\ & & \| & & \\ \mathrm{O:C} & = & \mathbf{Ni} & = & \mathrm{C:O} \\ & & \| & & \\ & & \mathrm{C} & & \\ & & \cdot\cdot & & \\ & & \mathrm{O} & & \end{array}$$

This view seems plausible, and in accordance with the chemical properties of the substance, and I should have no hesitation in accepting it if we had not, in the further pursuit of our work on metallic carbonyls, met with another substance—a liquid compound of iron with carbonic oxide—which in its properties bears so much resemblance to the nickel compound that one cannot assign to it a different constitution, whilst its composition makes the adoption of a similar structural formula next to impossible. It contains, for one equivalent of iron, five equivalents of carbonyl. To assign to it a similar constitution, one would, therefore, have to assume that iron did exercise ten valencies, or two more than any other known element, a view which very few chemists would be prepared to countenance. The atomic refraction of iron in this compound, which Dr. Gladstone has had the kindness to determine, is as unusual as that of the nickel in the nickel compound, and bears about the same ratio to the atomic refraction of iron in other compounds. We have, therefore, to find another explanation for the extraordinarily high atomic refraction of these metals in their compounds with carbon monoxide, which may possibly modify our present view on this subject. As to the structure of these compounds themselves, we are almost bound to assume that they contain the carbonyl atoms in the form of a chain.

The ferro-carbonyl is prepared in a similar manner to the nickel compound. The iron used is obtained by heating iron oxalate at the very lowest temperature possible. This carbonyl forms, however, with such very great difficulty, that we overlooked its existence for a long time, and great precautions have to be taken to obtain even a small quantity of it. It forms an amber-coloured liquid, of which I have a small quantity before me. It solidifies below $-21°$ C. to a mass of needle-shaped crystals. On heating the vapour to 180° C., it is completely decomposed into iron and carbonic oxide. The iron mirrors before me have been obtained in this way. Its chemical composition is $Fe(CO)_5$.

It is interesting that, within a short time after we had made known the existence of this body, Sir Henry Roscoe found it in carbonic oxide gas which had stood compressed in an iron cylinder for a considerable time, and expressed the opinion that the red deposit which sometimes forms in ordinary steatite gas-burners is due to the presence of this substance in ordinary illuminating gas. Its presence in compressed gas used for lime-lights has been noticed by Dr. Thorne, whose attention was called to the fact that this gas sometimes will not give a proper light because the incandescent lime becomes covered with oxide of iron.

M. Garnier, in a paper communicated to the French Academy of Sciences, supposes even that this gas is sometimes formed in large quantities in blast-furnaces when they are working too cold, and refers to some instances in which he found large deposits of oxide of iron in the tubes leading away the gas from these furnaces. I find it difficult to believe that the temperature of a blast-furnace could ever be sufficiently reduced as to give rise to the formation of this compound. On the other hand, it is highly probable that the formation of this compound of iron and carbonic oxide may play an important *rôle* in that mysterious process by which we are still making, and have been making for ages, the finest qualities of steel, called the cementation process.

The chemical behaviour of the substance towards acids and oxidizing agents is exactly the same as that of the nickel compound, but to alkalies it behaves differently. The liquid dissolves without evolution of gas. After a while a greenish precipitate is formed, which contains chiefly hydrated-ferrous oxide, and the solution becomes brown. On exposure to the air, it takes up oxygen; the colour changes to a dark red, whilst hydrated ferric oxide separates out.

We have so far not been able to obtain from this solution any compound fit for analysis, and are still engaged upon unravelling the nature of the reaction that takes place, and of the compounds that are formed.

Although the solution resembles in appearance to some extent the solutions obtained by treating potassium carbonyl with water, it does not give any of the characteristic reactions of the latter.

When speaking of potassium carbonyl, I mentioned that, by its treatment with water, croconate of potassium was obtained, which has the formula $K_2C_5O_5$. We have transformed this by double decomposition into ferrous croconate (FeC_5O_5), a salt forming dark crystals of metallic lustre resembling iodine, which is not volatile, and dissolves readily in water, the solution giving all the well-known reactions of iron and of croconic acid. You will note how entirely different the properties of this substance are from those of iron carbonyl, which I have described to you; yet, on reference to its composition, you will find that it contains exactly the same number of atoms of iron, carbon, and oxygen as the latter. This is a very interesting case of isomerism, considering that both compounds contain only iron, carbon, and oxygen.

The difference in the properties of these two bodies becomes explainable by comparing the structural formula of the two substances.

I would now call your attention to the great difference in the constitution of the potassium carbonyl and that of the nickel and ferro carbonyl. In the former the metal potassium is combined with the oxygen in the carbonyl; in the latter the metals nickel and iron are combined with the carbon of carbonyl. In the first case we have a benzole ring with its three single and three double bonds; in the second a closed chain with only single bonds. It is evident that the chemical properties of these substances must be widely different.

The ferro-penta-carbonyl remains perfectly unchanged in the dark, but if it is exposed to sunlight it is transformed into a solid body of remarkably fine appearance, of gold colour and lustre, as shown by the sample in this tube.

This solid body is not volatile, but on heating it in the absence of air, iron separates out and liquid ferro-carbonyl distils over. If, however, it is heated carefully in a current of carbonic oxide it is reconverted into the ferro-penta-carbonyl, and completely volatilized. We have so far found no solvent for this substance, so that we have no means as yet of obtaining it in a perfectly pure state. Several determinations of the iron in different samples of the substance have led to fairly concordant figures, which agree with the formula $Fe_2(CO)_7$, or di ferro-hepta-carbonyl.

The interesting properties of the substances described have naturally led us "to try," as Lord Kelvin once put it to me so prettily, "to give wings to other heavy metals." We have tried all the well-known and a very large number of the rarer metals; but with the exception of nickel and iron we have so far been entirely unsuccessful. Even cobalt, which is so very like nickel, has not yielded the smallest trace of a carbonyl. This led me to study the question whether, by means of the action of carbonic oxide, the separation on a large scale of nickel from cobalt could not be effected, which has so far been a most complicated metallurgical operation; and subsequently I was led to investigate whether it would not be possible to use carbonic oxide to extract nickel industrially direct from its ores.

It had been established that pure nickel prepared with very great precautions in a glass tube, could be partly volatilized by carbonic oxide, and that from the gas thus obtained the nickel could be separated again by heating. The questions to be studied were, therefore, whether it would be possible to reduce the ores, on an industrial scale, under such conditions as to obtain the nickel in a sufficiently finely divided and active a state that the carbonic oxide would volatilize it; whether such action would be sufficiently rapid to allow of its industrial application; whether it would be sufficiently complete to remove all the nickel from the ore; and whether none of the other constituents of the ore would pass with the nickel and render it unfit for use; and further, whether the nickel could be completely separated out of the gas within practical limits; and whether the recovered carbonic oxide could be made use of over and over again.

For solving these problems within the limits of the resources of a laboratory, I have devised apparatus which consists of a cylinder divided into many compartments, through which the properly prepared ore is passed very slowly by means of stirrers attached to a shaft. On leaving the bottom of this cylinder, the ore passes through a transporting screw, and from this to an elevator, which returns it to the top of the cylinder, so that it passes many times through the cylinder, until all the nickel is volatilized. Into the bottom of this cylinder we pass carbonic oxide, which leaves it at the top charged with nickel carbonyl vapour, and passes through the conduits shown here into tubes set in a furnace and heated to 200°. Here the nickel separates out from the nickel carbonyl. The carbonic oxide is regenerated and taken back to the cylinder by means of a fan, so that the same gas is made to carry fresh quantities of nickel out of the ore in the cylinder, and to deposit it in these tubes an infinite number of times.

Upon these principles Dr. Langer has constructed a complete plant on a Liliputian scale, which has been at work in my laboratory for a considerable time, and a photograph of which we will now throw on to the screen. You see here the volatilizing cylinder divided into numerous compartments, through which the ore is passing, and subjected to the action of carbonic oxide. At the bottom the ore is delivered into the transporting screw, passing through a furnace, and from this screw into an elevator, which returns the ore to the top of the cylinder, so that the ore constantly passes at a slow rate through the cylinder again and again, until the nickel it contains has been taken out. The carbonic oxide gas, prepared in any convenient manner, enters the bottom of the cylinder and comes out again at the top. It then passes through a filter to retain any dust it may carry away, and thence into a series of iron tubes built into a furnace, where they are heated to about 200° C. In these tubes the nickel carbonyl carried off by the carbonic oxide is completely decomposed, and the nickel deposited against the sides of the tubes is from time to time withdrawn, and is thus obtained in the pieces of tubing and the plates which you see on the table.

The carbonic oxide regenerated in these tubes is passed through another filter, thence through a lime purifier, to absorb any carbonic acid which may have been formed through the action of the finely-divided nickel upon the carbonic oxide, and is then returned through a small fan into the bottom of the cylinder. The whole of this plant is automatically kept in motion by means of an electric motor, and the gearing which you see here.

By means of this apparatus we have succeeded in extracting the nickel from a great variety of ores, in a time varying, according to the nature of the ore, between a few hours and several days.

Before the end of this year this process is going to be established in Birmingham on a scale that will enable me to place its industrial capacity beyond a doubt, so that I feel justified in the expectation that in a few months nickel carbonyl, a substance quite unknown two years ago, and to-day still a great rarity, which has not yet passed out of the chemical laboratory, will be produced in very large quantities, and will play an important *rôle* in metallurgy.

The process possesses, besides its great simplicity, the additional advantage that it is possible to immediately obtain the nickel in any definite form. If we deposit it in tubes we obtain nickel tubes; if we deposit it in a globe we obtain a globe of nickel; if we deposit it in any heated mould we obtain copies of these moulds in pure, firmly coherent, metallic nickel. A deposit of nickel reproduces the most minute details of the surface of the moulds to fully the same extent as galvanic reproductions. All the very numerous objects now produced by galvanic deposition, of which Mr. Swan exhibited here such a large and beautiful variety a fortnight ago, can thus be produced by this process with the same perfection in pure metallic nickel. It is equally easy to nickel-plate any surface which will withstand the temperature of 180° C. by heating it to that temperature and exposing it to the vapour, or even to a solution of nickel carbonyl, a process which may in many cases have advantages over electroplating. I have on the table before me specimens of nickel ores we have thus treated, of nickel tubes and plates we have obtained from these ores, and a few specimens of articles of pure nickel and articles plated with nickel which have been prepared in my laboratory. These will give you some idea of the prospects which the process I have described opens out to the metallurgist, upon whom, from day to day, greater demands are made to supply pure nickel in quantities. The most valuable properties of the alloy of nickel and iron called nickel-steel, which promises to supply us with impenetrable ironclads, have made an abundant and cheap supply of this metal a question of national importance. The inspection of the few specimens of articles of pure nickel and of nickel-plated articles will, I hope, suffice to show you the great facilities the process offers for producing very fine copies, and for making articles of such forms as cannot be produced by hydraulic pressure, the only method hitherto available for manufacturing articles of pure nickel.

The first practical use of the process has been made by Prof. Ramsay, who, for the purposes of a chemical investigation, made this beautiful little apparatus of pure nickel all in one piece, which he has kindly lent for exhibition to-night.

I began my lecture by bringing under your notice an idea of Liebig's which he published fifty-eight years ago. I have shown you how he himself elaborated this idea, and how it developed, until within recent years it has led to results of the highest scientific importance and probably of great practical utility.

Had Liebig all these results before his "mind's eye" when he penned those prophetic words I have quoted? This is a question impossible to answer. Who will attempt to measure the range of vision of our great men, who from their lofty pinnacle see with eagle eye far into the Land of Science, and reveal to us wonderful sights which we can only realize after toiling slowly along the road they have indicated? Whether Liebig saw all these results or not, it is due to him and to men like him that science continues its marvellous advance, dispersing the darkness around us, and ever adding to the scope and exactness of our knowledge, that mighty power for promoting the progress and enhancing the happiness of humanity.

NORTH-WESTERN DISTRICT OF BRITISH GUIANA.

At the meeting of the Royal Geographical Society on Monday evening, Mr. Everard im Thurn described the general characteristics of the new district in the north-west of British Guiana in the settlement and administration of which he has been employed for the last ten years. The colony of British Guiana he described as formed of a low swampy coast strip, often below the level of the sea, densely covered with mangroves, and intersected by rivers bound together by interlacing channels. Farther inland the mangroves pass into forests of tropical trees, which, as the land rises more steeply, are reduced to strips along the rivers, and finally merge into dry grassy uplands known as savannahs. The north-western district of the colony is officially defined as the territory bounded on the north by the Atlantic Ocean and the mouth of the River Orinoco; on the south by the ridge of land between the sources of the Amakuru, Barima, and Waini Rivers, and their tributaries, and the sources of the tributaries of the Cuyuni River; on the east by a line extending from the Atlantic Ocean in a southerly direction to the said ridge of land; on the south and on the west, by the Amakuru River and the line known as Schomburgh's line.

Mr. im Thurn's first task was to explore his territory, and this he did mainly by boat along the rivers and their connecting channels, traversing country never before visited by white men. The nature of this mode of travelling was very vividly described. On ascending the Moruka, the country on each side of the river was seen to become gradually more and more open—the river at last often winding through open savannahs, and broadening out here and there into pools so thickly set with water-lilies that the boat was forced through with difficulty. The waterway after some time leaves the river and passes along a narrow itabbo, or artificial water-path, which connects the Moruka with the Waini River. This connecting passage is about thirty miles long, and about ten miles is semi-artificial itabbo, made by the constant passage of the canoes of the Redmen through the swampy savannah, and very difficult to get through. Generally, it was hardly wider than the boat, and had many abrupt windings; the trees hung down so low over the water, that it was hard work either to force the boat under the low-lying branches, or to cut these away, and so make a passage. On either side of the channel the ground is so swampy as rarely to allow foothold of even a few inches in extent. The light hardly penetrates through the dense roof of leaves; and in the gloom under the roof only a few aroids, ferns, lilies, and orchids, and great masses of a palm previously undescribed.

The itabbo passed, the boat turned suddenly into the Barabara River itself, at first narrow, but soon widening and winding on its course through dense and unbroken bush, chiefly composed of the graceful, swaying manicole palms (*Euterpe edulis*). Very abundant, perched high up and low down among this dense bush, were great quantities of an orchid with stems eight and nine feet long, loaded with its countless butterfly-like yellow flowers (*Oncidium altissinum*). After a few miles the Barabara River led into the Biara, a river of much the same character, which, though naturally larger than the Barabara, was still so small as hardly to deserve more than the local name of creek. And, again, in a few miles the Biara carried the boat into the Baramanni River, which is about 100 or 150 yards wide, and very deep. This is, in fact, not a river at all, but a very elongated lake or lagoon, of perhaps twenty miles in length, the lower end opening into the Waini, while the upper end discharges part of its surplus water into the sea. Anything more maze-like than the itabbo between the Waini and Barima Rivers it is impossible to imagine.

On the Aruka, a large tributary of the Barima, the curious Arawack game of the Macquari whip is played, the essential feature of which is a testing of endurance by means of alternately giving and receiving severe cuts with a somewhat severe whip. This extraordinary performance, accompanied with much drinking and with invariable good humour, is carried on for some days in accordance with a fixed ritual, the blows, which are received by the players on the calves of their legs, being so severe as to draw much blood. The river, too, must at one time have been the site of a Redskin civilization far superior to, and very different from, any known previously of the early inhabitants of Guiana; for there are on it considerable deposits of pottery ornamented with incised patterns, and even very abundantly with grotesque figures of men and animals in very high relief. To estimate the significance of this latter fact, it must be remembered that none of the known early inhabitants of Guiana have advanced in the important primitive art of pottery beyond the stage of making vessels of two or three definite and very simple shapes, which are almost invariably entirely without ornament, or are at best, in a very few cases, ornamented with a simple pattern painted on the flat surface.

The Warrau Redmen inhabiting a neighbouring region have recourse to a picturesque game in order to decide disputes amicably. For this purpose, on an appointed day both parties come together on some open space, such as this sand-bank, each man or boy provided with a large shield made of the leaf-stalks of the aeta palm (*Mauritia flexuosa*). After much shouting and dancing in two opposed lines, the shields of the one party are pushed against those of the other, and by this means the members of each party endeavoured by sheer strength to overthrow, or at least to force back from their position, the members of the other party; and the right in the matter in dispute is considered to lie with whichever party proves itself the stronger in this contest. The game is peculiar to the swamp Warraus, who live in the swamps of the mouths of the Orinoco, and live here chiefly on the aeta palm, not cultivating any food-stuff, but eating the fruit of this palm and the pith of its stem, not making any fermented drink, as other Redmen do, but drinking only water and the sap of this same palm, building their houses, not as Humboldt thought, actually *in* these palms, but yet entirely, floor, posts, and roof, *of* the various parts of this palm. The physical features of the north-western district are like, yet in some respects different from, those of the rest of the colony. The watershed from which the main rivers, the Waini, Barama, Barima, and the Amakuru, run down to the sea, is here nearer to the coast-line than it is further south. Two more important consequences arise from this. The bare dry savannah of the interior of other parts of the colony is here unrepresented, the whole district being practically within the forest belt. And the rivers are both shorter and deeper, though their mouths are very wide. Moreover, these rivers are curiously connected both by a remarkably elaborate network, probably hardly paralleled in any other part of the world, of natural and semi-natural water channels—such as those described—and by an almost equally elaborate network of Redmen's paths through the forest.

The inhabitants of this district were, ten years ago, Redmen, and Redmen only. Their distribution is interesting when taken in connection with the distribution of their kind throughout the colony. The Redmen of Guiana consist of many small tribes, the best known of which are the Arawacks and the so-called Caribs—true Caribs they are preferably called. These two last-named tribes owe the fact that they are the best known to the circumstance that they shared between them the West Indian Islands south of Jamaica at the time of their discovery by Columbus; and they are the last remnants of those people who were the victims of that brutal policy of extermination by cruelty followed by the Spanish conquerors of the New World. The north-western district is some 9500 square miles in extent, and rises gradually from the sea to the range of somewhat higher land, which is represented, with some exaggeration, on most existing maps as the Sierra Imataca range of mountains, but which, within the limits of British Guiana, never attains a general level of more than 300 or 400 feet. The lower or alluvial part of this country consists of some of the richest soil in the world. Parts which have since been taken in and drained now yield crops of tropical produce of simply amazing abundance. As an illustration, a garden which hardly two and a half years ago was cleared and drained already has in it avenues of trees (*Casuarina*) of over 40 feet high, which were then planted. On the other hand, the higher part of the new district is being fast overrun by very successful gold-diggers.

For geographical reasons the most convenient centre from which to administer the district was at the point at which the Morawhanna leaves the Barima. This is near the centre of the waterway which traverses the northern part of the colony from the sugar fields about the mouth of the Essequibo to its northern limits on the Orinoco, by which, in the absence of roads, all traffic from the Orinoco to the older established parts of the colony must necessarily pass. Here, therefore, the central station, with the Government Agency, the police barracks, the hospital, and the other buildings, public and private, which go to make up the chief township, have been placed, and are fast being added to. A large station, with the other necessary accommodation, was also placed at the northern end of the waterway, on the mouth of the Amakuru; and other stations have been placed at intervals along the whole line.

SCIENTIFIC SERIALS.

THE *American Meteorological Journal* for May contains a paper read by Prof. W. M. Davis, before the New England Meteorological Society, entitled "Meteorology in the Schools." It points out the best plan to be adopted by a teacher to give his pupils a sound knowledge of the subject, and it will be found full of interest for many who may have made considerable progress in the study of meteorology. The complete solution of weather changes is far beyond the meteorology of the day, but the paper will teach the student to recognize the great difficulties attendant upon successful weather-predictions, and to discriminate between these and the predictions of those who pretend to outline the course of meteorological events for months ahead.—Thunderstorms in New England during the year 1886, by R. De C. Ward. The observation of thunderstorms was taken as a special subject of investigation by the New England Meteorological Society in the years 1885–87, and this paper is a preliminary report on the investigation, to be eventually published by the Harvard College. The storms were most frequent between May and August, and between 5h. and 7h. p.m. The average rate of movement throughout the year was 35 miles an hour. The influence of the tides on the direction of the storms is said to be brought out in several reports.—The storm of March 1–4, 1892, by J. Warren Smith. This storm was so severe in the New England States, and the snowfall and drift so heavy, as to cause in many places the cessation of all outside business; trains were blocked, and much damage done to shipping from the violence of the wind.

THE *American Meteorological Journal* for June contains the following original articles:—Flood-stage river predictions, by Prof. T. Russell. The paper gives some account of the methods by which the rules for river-stage predictions are derived. A river-stage is the vertical height of the water surface above the plane of low water, observed with a gauge. There are about 150 gauge stations maintained at various points in the United States. The predictions are mainly based upon observation of the stages and rises at certain points of a stream, and upon a consideration of what has occurred in previous cases, from which data factors are calculated. As a rule, rainfall observations are of little use in such predictions.—The first scientific balloon voyage, translated by R. De C. Ward, from an article by Dr. Hellmann. (See NATURE, vol. xlv. p. 471.)—Snowstorms at Chicago, by A. B. Crane. The writer has tabulated the records relating to the subject from 1879-90, and has discussed them with reference to the meteorological conditions prior to the storm. The heaviest storms occurred in January, the average temperature being 21°·4. He found that before the storms the temperature nearly always rises, and that it rarely falls for twenty-four hours previously.—The eye of the storm, by S. M. Ballou. This name is given to the calm area in the centre of a cyclone, where clear sky is generally visible. The author quotes accounts by various observers, and a review of the different explanations of the phenomenon.—Shall we erect lightning-rods?, by A. McAdie. The question being whether it is cheaper to insure buildings than to incur the expense of erecting lightning-rods, the author quotes a number of authorities in support of the advisability of putting up rods, and gives rules to be observed in doing so.

Bulletin of the New York Mathematical Society, vol. i., Nos. 8 and 9 (New York, 1892).—The illustrious German mathematician, Leopold Kronecker, died recently at Berlin (December 29, 1891). No. 8 (pp. 173–84) opens with a most interesting article, by H. B. Fine, entitled "Kronecker and his Arithmetical Theory of the Algebraic Equation." This is biographical and analytical. A short note, by Prof. Cajori, follows, on the "Multiplication of Series." The concluding note is by Dr. Macfarlane, "On Exact Analysis as the Basis of Language." This is a brief abstract of a paper read before the Society (March 5, 1892).—No. 9 gives an account of a recent paper in the *Mathematische Annalen* (vol. xxxviii.), by M. Hilbert, under the head "Topology of Algebraic Curves." The writer, L. S. Hulburt, recasts the theory, with the view of making the theory more intelligible, and corrects some slight inaccuracies. Dr. Merriman abstracts a paper (read before the Society) on "Final Formulas for the Algebraic Solution of Quartic Equations." This number closes with a full account of Poincaré's "Mécanique Céleste," by E. W. Brown. The usual short notes and list of new publications are given at the end of each number.

Memoirs of the Mathematical Section of the Odessa University, vol. xiii.—On the theory of linear differential equations, by M. Rudzky.—The mechanics of a system subject to similar changes, by D. Seiliger, part iii. The paper is followed by a description of an apparatus, the "homoyograph," three spots of which always take such positions as to make similar triangles.—Experimental researches into the compressibility of glass and mercury, by G. De-Metz. The absolute compressibility of mercury has been determined on the two methods of Regnault and Jamin, as also on a third method which results from the equations of Lamé in his "Leçons sur l'Élasticité," and the seventh memoir of Regnault. The results arrived at in these very elaborate researches are very near to those arrived at by Amagat.—Volume xii. of the same periodical consists of a work by J. Timtchenko, on the foundations of the theory of analytical functions. The aim of the author is to contribute towards the elaboration of a *general* theory of functions which would include Weierstrass's theory as well. The first part, now published, contains the historical review of the development of the theory.

Bulletin de la Société des Naturalistes de Moscou, 1891, Nos. 2 and 3.—The Speeton clays and their equivalents, by A. Pavloff and G. W. Lamplugh.—Contributions to the study of molecular forces in chemically simple bodies, on the ground of thermodynamics, by J. Weinberg.—Studies on the development of Amphipodes, part v., by Madame Catherine Wagner (in French, with two plates). The development of the embryo of the *Melita palmata* is apparently quite similar to that of *Gammarus* and *Caprella* in its earlier stages, but the microscopic observation of cuttings through the embryo discloses several interesting peculiarities, which are described and illustrated.—What is the Hipparion?, by Marie Pavloff (in French), being an answer to critical remarks, by M. Trouessart, in *Annuaire Géologique Universel*, tome vi., relative to Marie Pavloff's work on the evolution of Ungulates.—On a new apparatus for determining the moment of inertia of a body, by N. Joukovsky (in French).—On *Pteromonas alata*, Cohn, by M. Golenkin (in German).—The present state of our knowledge of the contents of the cells of the Phycochromaceæ, by Valerian Deinega (in German). The author has come to no definite results as to the nucleus in the Phycochromaceæ, especially in the thread-like species; new colouring methods ought to be discovered.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 2.—"Supplementary Report on Explorations of Erect Trees containing Animal Remains in the Coal-formation of Nova Scotia." By Sir J. William Dawson, F.R.S.

To the memoir which I had the honour to present to the Royal Society on this subject in 1882[1] I appended a note from Dr. Scudder, of Cambridge, U.S., so well known for his researches in fossil Insects and Arachnidans, in which he gave a preliminary account of the remains of Arthropods in my collections which I had submitted to him. He has only in the present year completed his examination of these remains, most of which are very fragmentary, and much damaged by unequal pressure. The result has been embodied in a Report on Canadian Fossil Insects, now in course of publication by the Geological Survey of Canada.

In this Report he will describe from the contents of the Sigillarian stumps extracted by me, with the aid of the grant of this Society, three new species of Myriapoda, making, with the five previously known from these remarkable repositories, eight in all, belonging to two families, Archiulidæ and Euphoberidæ, and to three genera, *Archiulus*, *Xylobius*, and *Amynilyspes*. The three new species are *Archiulus euphoberioides*, Sc., *A. Lyelli*, Sc., and *Amynilyspes* (sp.). The remains of Scorpions he refers to three species, *Mazonia acadica*, Sc., *Mazonia* (sp.), and a third represented only by small fragments. The characters of the species referred to *Mazonia* he considers as tending to establish the generic distinctness of *Mazonia* from *Eoscorpius*. Dr. Scudder also notices the fragment of an insect's head containing part of a facetted eye, mentioned in my memoir, and considers it probably a portion of a Cockroach.

Much credit is due to Dr. Scudder for the care and skill with which he has worked up the mostly small and obscure fragments which I was able to submit to him, and which are probably little more than *débris* of the food of the Amphibians living for a time in these hollow stumps, and devouring such smaller animals as were so unfortunate as to be imprisoned with them. In this connection the suggestion of Dr. Scudder is worthy of attention, that the scaly armour of the smaller Microsaurians may have been intended to defend them against the active and venomous Scorpions which were their contemporaries, and some of which were sufficiently large to be formidable antagonists to the smaller land Vertebrates of the period.

The report of Dr. Scudder will complete the account of the land animals of the erect Sigillariæ of the South Joggins, unless by new falls of the cliff fresh trees should be exposed. From 1851, when the first remains were obtained from these singular repositories by the late Sir Charles Lyell and the writer, up to the present time, they have afforded the remains of twelve species of Amphibians, three land Snails, eight Millipedes, three Scorpions, and an Insect.

The type specimens of these animals have been placed in the Peter Redpath Museum of McGill University, and such duplicates as are available will be sent to the British Museum and that of the Geological Survey of Canada.

June 16.—"On the Estimation of Uric Acid in Urine." By F. Gowland Hopkins.

The process described depends upon the complete insolubility of ammonium urate in saturated solutions of ammonium chloride.

The pure chloride is powdered, and added to the sample to complete saturation. After two hours' standing, the whole of the uric acid separates as biurate of ammonium. The urate is then decomposed with hydrochloric acid, and the liberated uric acid determined by any approved method. In contrast to the well-known Fokker-Salkowski process the separation is rapid and complete.

The author has experimented with permanganate solutions for the titration of the separated uric acid, and finds that accurate results may be obtained by their employment. For this purpose the uric acid is dissolved in 100 cc. of water, with a minimum of Na_2CO_3, 20 cc. of strong H_2SO_4 being then added, and the solution immediately titrated with one-twentieth normal permanganate of potassium. The addition of 20 per cent. H_2SO_4 to the previously cooled solution of sodium urate yields just such a temperature (about 60°C.) as is requisite for a determinate reaction. 1 cc. of the permanganate solution is equal to 0·00375 grm. uric acid.

Physical Society, June 24.—Prof. A. W. Rücker, F.R.S., in the chair.—The following communications were made:—On breath figures, by Mr. W. B. Croft. After mentioning the observations of early experimenters on the subject, the author described a method which he found to give the best results. A coin is placed on a glass plate for insulation; another glass plate, which is to receive the impression, is well polished and laid on the coin, whilst a second coin is placed above the first. The coins are put in connection with the poles of an electrical machine, giving one-inch sparks for two minutes. When the coins are removed and the glass breathed on, clear frosted pictures of the coins are seen on the glass. The microscope shows that moisture is deposited on the whole surface, the size of the minute water granulation increasing as the part of the picture is darker in shade. The thickness of the glass seemed to make no difference to the result, and several plates and coins might be piled up alternately. If carefully protected, time appears to have little effect on the figures, but they can be removed by rubbing whilst the glass is moist. Failures and their causes were discussed, and the more complex phenomena produced by strong discharges described. It was also pointed out that breath figures could be produced by laying a coin on a freshly split surface of mica, and that a coin laid on glass for some time leaves its traces. Perfect reproductions of printed matter have been obtained by placing a paper printed on one side only between two sheets of glass for ten hours. Some substances, such as silk in contact with glass, give white figures; whilst wool, cotton, &c., give black ones. Various analogous effects are noticed in the paper, and the several views put forward in explanation of the phenomena examined.—A communication on the same subject, from the Rev. F. J. Smith, was read by Prof. Perry. He had investigated some of the effects, and succeeded in photographing the impressions, prints from which were shown. He had also examined the influence of various gases on the results, and found that oxygen gave the best figures. In a vacuum no figures could be obtained. The effect of temperature had also been tested. Prof. S. P. Thompson said details of early researches were given in *Poggendorff's Annalen* for 1842. It was there pointed out that better results were obtained by putting a spark gap between the coin and the machine. Since the effects did not depend on the way in which the sparks passed, he thought it was probable that electrical oscillations were involved. He himself had worked at the subject in 1881, and recently repeated some of the experiments. Figures could be produced on almost any polished surface; he got the best results by using a small induction coil giving 3 mm. spark, for about five seconds. In 1881 he accidentally noticed that photographs could be got on ebonite. Hot coins put on uncleaned glass gave good breath figures. A member said that instead of breathing on the plates, he and Mr. Garrett had sifted finely powdered red lead on them, to get the figures. They had also fixed the figures by etching with hydrofluoric acid. Mr. Croft exhibited some figures he obtained two years ago, which were still quite distinct.—On the measurement of the internal resistance of cells, by Mr. E. Wythe Smith. After referring to the methods hitherto used, the author described a modification of Mance's test which he had recently devised. One pole of the battery to be tested is connected to the similar poles of two other batteries; each battery has a separate circuit, through which currents are allowed to pass. Selecting a point A at the opposite pole of the battery to be tested, points B and C in the circuits of the auxiliary batteries are found, whose potentials are equal to that of A. The resistances between each pair of points AB, AC, BC, are then measured by a Wheatstone's bridge. Calling these resistances R_1, R_2, and R_3 respectively, it is shown that the internal resistance required is given by the formula $b = x + \frac{x^2}{r} + \frac{x^3}{r^2} + \&c.$, where $x = \frac{R_1 + R_2 - R_3}{2}$, and r is the external resistance of the circuit containing the battery tested. For an accumulator discharging, $b = x$ to within about 2 per cent. Prof. Perry inquired how far the results obtained agreed with those got by the older methods, and whether they depended on the time the keys were kept down. In the old methods it was assumed that an instantaneous rise in P.D. occurred on breaking the circuit. This might or might not be true. He was inclined to regard the P.D. and current as functions, both of resistance and time. The behaviour of cells seemed to indicate the existence of something like capacity, or rather, capacities and resistances in series. Prof. Ayrton said the paper was of great interest, for it made possible what could not be done before, viz. to find the resistance of a cell without appreciably altering the current through it. Although the new method required more cells, this was not prohibitive, for the result sought was of considerable scientific importance. The same method was applicable for finding the resistance of dynamo-armatures when working, a quantity which had hitherto been unattainable by direct measurement. Mr. Lane Fox said the perplexing changes in the P.D. of secondary cells were to be accounted for by changes in the electrolyte, which occurred in the pores of the plates. He could detect no flaw in the reasoning given in the paper. Dr. Sumpner remarked that the method was a valuable one, for it depended on bridge tests which could be made with considerable accuracy. On the other hand, it was a false zero method, and therefore liable to errors arising from changes of this zero. Prof. Ayrton pointed out that these errors could be eliminated by reversing the bridge battery. Mr. Rimington said although the testing currents were small they might affect the E.M.F., and thus introduce an error in b. This might be tested by using alternate currents and a telephone. In reply to Prof. Perry, Mr. Smith said the results agreed with those obtained by the older methods to within the limits of accuracy obtainable by the latter methods; this might amount to something like 15 per cent.—On the relation of the dimensions of physical quantities to directions in space, by Mr. W. Williams. In February 1889, Prof. Rücker recalled attention to the fact that, in the ordinary dimensional formulæ for electrical quantities, the dimensions of μ (permeability) and k (specific inductive capacity) are suppressed. In the discussion on that paper Prof. S. P. Thompson pointed out that lengths should be considered as having direction as well as magnitude, for, if so regarded, difficulties arising from different units, such as *couple* and *work*, having the same dimensions, would be avoided. Developing this idea, the author takes three mutually perpendicular lines, along which lengths are measured. Calling unit lengths along these lines X, Y, and Z respectively, the various dynamical units, such as velocity, acceleration, force, work, &c., are expressed in terms of M, T, X, Y, and Z. The formulæ then denote the directional as well as the numerical relations between the units, and the dimensional formulæ are therefore regarded as the symbolical expressions of the physical nature of the quantities, so far as they depend on lengths, mass, and time. In this system areas and volumes are represented by products of different vector lengths instead of by powers of a single length, and angles and angular displacements by quotients of rectangular vectors, instead of being pure numbers. For physical purposes pure numbers may be defined as ratios of concretes of the same kind similarly directed (if directed at all). A plane angle has dimensions $X^{-1}Y$, X being in the direction of the radius, and Y that of the arc, whilst solid angles have dimensions YZX^{-2}, and radii of curvature Y^2X^{-1}. It is also shown that π is a concrete quantity of the dimensions either of plane or of solid angle. This is of considerable importance in connection with the radial and circuital fluxes in the electromagnetic field. In deducing the dimensional formulæ for electrical and magnetic units, the rational and simplified relations given by Mr. Oliver Heaviside in the *Electrician* of October 16 and 30, 1891, are used. Instantaneous axes are taken at any point of an isotropic medium (the ether) such that X coincides with the electrical displacements, Y with that of the magnetic displacement, and Z with the intersection of the two equipotential surfaces at that point. Starting with the relation μH = energy per unit volume, the formulæ for the various quantities in terms of μ are obtained. These simplify down to those of the ordinary electro-magnetic system by putting $\mu = 1$ and suppressing the distinction between X, Y, and Z. Similarly, commencing with kE^2 = energy per unit volume, formulæ in terms of k are obtained, which, when simplified as above, give those of the ordinary electrostatic system. Examples of the consistent way in which the results work out are given in the paper, and the whole subject is discussed in detail, both by Cartesian and vectorial methods. The formulæ in terms of μ and k are used to trace out and examine the various analogies between electro-magnetism and dynamics, thereby obtaining a connected dynamical theory of electromagnetism. Inquiry is then made as to what dimensions of μ and k in terms of M, T, X, Y, Z, render the interpretation of electrical and magnetic units simple, natural, and intelligible as a whole. The conditions imposed (for reasons stated in the paper) are, first, that the dimensions of μ and k satisfy the relation $[\mu k] = Z^2T^{-2}$; second, that the powers of the fundamental units in the dimensional formulæ shall not be higher or lower than those found in the formulæ of the ordinary dynamical quantities; and, third, that quantities which are scalar or directed must also be scalar or directed when their dimensions are expressed absolutely. Subject to these conditions, it is shown that the possible dimensional values of μ and k are eight in number. Of these only two lead to intelligible results. These are—

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[1] Phil. Trans., 1882, p. 621.

$$(1)\ \mu = M(XYZ)^{-1} \text{ and } k = M^{-1}\,XYZ^{-1}T^2.$$

and

$$(2)\ \mu = M^{-1}XYZ^{-1}T^2 \text{ and } k = M(XYZ)^{-1}.$$

According to (1), μ is the density of the medium, electrical energy is potential, and magnetic energy kinetic. By (2), k is the density of the medium, electrical energy is kinetic, and magnetic energy potential. Full interpretations of the dimensional formulæ of all the electro-magnetic quantities, as obtained in accordance with the above conditions, are given in the paper. Prof. S. P. Thompson said the paper was a very important one, and thought the idea of finding dimensions for μ and k which would rationalize the ordinary dimensional formulæ a great step. The use of vectors was a valuable feature, whilst the employment of X, Y, and Z instead of L removed many difficulties connected with dimensional formulæ. Other difficulties might be cleared up by paying attention to the signs of the vector products and quotients, and to the order in which the symbols were written. Another important matter was the use of Mr. Heaviside's "rational units," a system which merited serious attention. In conclusion, Prof. Thompson expressed a hope that, in accordance with the resolution of the Electrical Congress at Frankfort, both permeability and specific inductive capacity should be designated by Greek symbols. Prof. O. Henrici expressed his admiration of the way in which the subject had been treated in the paper. He had long held that clear ideas of physical quantities were best got by vectorial methods. He also congratulated the author on his treatment of plane and solid angles as concrete quantities. In a communication addressed to the Secretaries, Prof. O. J. Lodge remarked that physicists in England were more or less familiar with the advantages of retaining μ and k in dimensional expressions before Prof. Rücker's paper of February 1889 brought the matter closely home to students. The system of mechanical dimensions suggested for electrical quantities in an Appendix to "Modern Views of Electricity" was not put forth as the only one possible, but as one having certain probabilities of truth in its favour. Prof. Rücker said that, although Mr. Williams and himself had talked over certain minor points in the paper, the main ideas brought forward were quite original, having been fully developed by Mr. Williams before he mentioned the subject to him (Prof. Rücker).—A paper on molecular forces, by Mr. W. Sutherland, communicated by Prof. Carey Foster, was taken as read. The Chairman announced that both this paper and that of Mr. Williams would be printed in the *Philosophical Magazine* during the long vacation, so that they could be fully discussed early next session.

Linnean Society, June 16.—Prof. Stewart, President, in the chair.—Mr. F. Enock exhibited some specimens of the Mustard Beetle, and gave an account of its recent depredations as observed by himself. So numerous was it that in walking down a single row of mustard, a distance of sixty-five yards, he had captured with a butterfly net upwards of 15,000, as he subsequently ascertained by counting a portion and weighing the remainder. The crop of mustard thus affected he regarded as destroyed.—Mr. R. I. Pocock exhibited and made some remarks upon a species of Peripatus (*P. juliformis*) from St. Vincent, of which five specimens had been collected by Mr. H. H. Smith for the Committee investigating the fauna and flora of the Lesser Antilles. The species was originally described so long ago as 1826, by the Rev. L. Guilding (*Zoological Journal*, vol. ii.), but from that time until the present no additional specimens had been procured there. As Guilding's types had been lost, and his descriptions are wanting in detail, this rediscovery was of considerable interest.—Mr. George Murray exhibited and described the type of a new order of Algæ, to which the name *Splachnidium rugosum* was given.—A paper was read by Prof. J. R. Henderson, entitled "Contributions to Indian Carcinology," and embodied an account of several little-known Crustaceans, and descriptions of some new species.—Mr. H. B. Guppy read a paper on "The Thames as an Agent in Plant Dispersal," in which several interesting facts were brought out, the observations being illustrated by specimens collected by the author, and a useful record given of the effects of exposure to sea-water, and of freezing, upon the germinating power of seeds.—Prof. F. Oliver gave an abstract of observations made by Miss M. F. Ewart, on some abnormal developments of the flowers of *Cypripedium*, illustrated by effective diagrams in coloured chalk.—Mr. R. I. Pocock contributed some "Supplementary Notes on the Fauna of the Mergui Archipelago," the result of his examination of some fresh material which had lately come to hand.—The evening was brought to a close by an exhibition by Mr. Carruthers, with the aid of the oxy-hydrogen lantern, of some beautiful slides of sections of fossil plants. A second series, zoological, exhibited by the President, included several minute organisms of extreme interest.—This meeting brought the session of 1891–92 to a close.

Anthropological Institute, June 21.—Edward B. Tylor, F.R.S., President, in the chair.—Dr. R. Wallaschek read a paper entitled "An Ethnological Inquiry into the Basis of our Musical System." In the course of the paper he pointed out that harmony is not a modern European invention, but known to many savage tribes, and even to the Hottentots and Bushmen. A regular bass accompaniment (to distinguish it from songs in harmonious intervals) is far more seldom to be met with, as the extreme simplicity of primitive songs does not admit of much variety in accompaniment. On the other hand, some savage tribes (Hottentots, Malays, Negroes) show an astonishingly great talent in accompanying European tunes by ear. Both keys, the major as well as the minor, occur in the songs of primitive races. Minor chords also occur occasionally. There is no internal connection between a peculiar key and a peculiar mood or disposition of mind. The diatonic scale does not seem to be a more recent invention than the pentatonic. The most ancient diatonic division is to be met with in instruments (pipes, flutes) of the Stone period. This early occurrence seems to be due to the fact that the diatonic scale is the most natural for the player's fingers, while it is at the same time the most effective. The diatonic system is neither an "artistic invention," nor a "scientific discovery," nor is it "natural" for the voice or the ear, nor based upon the laws and conditions of sounds, but it is the most natural for the hand, and the most practical for playing instruments.—Prof. Basil Hall Chamberlain then read a paper on some minor Japanese religious practices. After mentioning various miscellaneous usages and superstitions, the author treated chiefly of Japanese pilgrims and their ways, illustrating his remarks by an exhibition of a large collection of charms, sacred pictures, pilgrims' dresses, &c., brought together partly by himself, partly by Mr. Lafcadio Hearn. The collection included articles from the Shinto shrines of Ise and Izumo, from the "Thirty-three Holy Places" of Central Japan, from the "Eighty-eight Holy Places" of the island of Shikoku, from the temple of Asakusa in Tokyo, &c. The most curious was a sacred fire-drill from the great Shinto shrine of Izumo. This, together with a few of the other articles, has been presented by Prof. Chamberlain to the Pitt-Rivers Museum at Oxford. Another feature of the paper was the translation given of a Buddhist legend explaining the origin of the pilgrimage to the "Thirty-three Holy Places," and of some of the hymns intoned by the pilgrims.

Geological Society, June 22.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—Contribution to a knowledge of the Saurischia of Europe and Africa, by Prof. H. G. Seeley, F.R.S. The Saurischia are defined as terrestial unguiculate Ornithomorpha, with pubic bones directed downward, inward, and forward to meet in a ventral union. The forms of the pelvic bones vary with the length of the limbs, the acetabulum becoming perforate, the ilium more extended, the pubis and ischium more slender, and the sacrum narrower as the limb-bones elongate. The order is regarded as including the Cetiosauria, Megalosauria, and Aristosuchia or Compsognatha. The Cetiosaurian pelvis has been figured in the *Quart. Journ. Geol. Soc.*; and a restoration is now given of the pelvis in *Megalosaurus*, *Streptospondylus*, and *Compsognathus*. The characters of the skull are evidenced by description of the hinder part of the skull in *Megalosaurus* found at Kirklington, and preserved in the Oxford University Museum. In form and proportions it closely resembles *Ceratosaurus*, and the corresponding region of the head in Jurassic Ornithosauria. The brain-cavity and cranial nerves are described, and contrasted with those of *Ceratosaurus*. The skull in Cetiosauria, known from the American type *Diplodocus*, is identified in the European genus *Belodon*, which is regarded as a primitive Cetiosaurian. Part 2 discusses the pelvis of *Belodon*, restored from specimens in the British Museum, and regarded as Cetiosaurian. A restoration of the shoulder-girdle is made, and found to resemble that in Ichthyosaurs, Anomodonts, and Dinosauria. The vertebræ in form and articulation of the ribs are Saurischian, the capitular and tubercular facets being vertical in the dorsal region, and not horizontal as in Crocodiles. The humerus shows some characters in common with that of *Stereorachis dominans*, in the epicondylar groove. In general character the limb-bones are more crocodilian than the axial skeleton. The interclavicle is described and regarded as a family characteristic of the Belodontidæ. In the third part an account is given of *Staganolepis*, which is regarded as showing a similar relation with the Megalosauria, to that of *Belodon* with the Cetiosauria. This interpretation is based chiefly upon the identification of the pubic bone in *Staganolepis*, which has the proximal end notched as in *Zanclodon* and *Streptospondylus*; and the inner ridge at the proximal end is developed into an internal plate. A note follows on the pelvis of *Aëtosaurus*, which is also referred to the Saurischia on evidence of its pelvic characters, approximating to the Cetiosaurian sub-order. Part 4 treats of *Zanclodon*, which is regarded as closely allied to *Massospondylus*, *Euskelesaurus*, and *Streptospondylus*. It is founded chiefly on specimens in the Royal Museum at Stuttgart, and in the University Museum at Tübingen. The latter are regarded as possibly referable to *Teratosaurus*, but are mentioned as *Zanclodon Quenstedti*. The pelvis is described and restored. *Zanclodon* has the cervical vertebræ relatively long, as compared with *Megalosaurus*, and small as compared with the dorsal vertebræ, which have the same Teleosauroid mode of union with the neural arch as is seen in *Streptospondylus* and *Massospondylus*. The sternum, of Pleininger, is the right and left pubic bones; but there is much the same difference in the proximal articular ends of those bones in the fossils at Stuttgart and Tübingen, as distinguishes corresponding parts of the pubes in *Megalosaurus* and *Streptospondylus*. The ilium is more like that of *Palæosaurus* and *Dimodosaurus*. The limb-bones and digits are most like those of *Dimodosaurus*, but the teeth resemble *Palæosaurus*, *Euskelesaurus*, *Megalosaurus*, and *Streptospondylus*. Part 5 discusses *Thecodontosaurus* and *Palæosaurus* upon evidence from the Dolomitic Conglomerate in the Bristol Museum. An attempt is made to separate the remains into those referable to *Thecodontosaurus* and those belonging to *Palæosaurus*. The latter is represented by dorsal and caudal vertebræ, a scapular arch, humerus, ulna (?), metacarpals, ilium, femur, tibia, fibula, metatarsals, and phalanges. These portions of the skeleton are described. There is throughout a strong resemblance to *Zanclodon* and other Triassic types. A new type of ilium, and the humerus originally figured, are referred to *Thecodontosaurus*. Part 6 gives an account of the South African genus *Massospondylus*. It is based partly upon the collection from Beaucherf, in the Museum of the Royal College of Surgeons, referred to *M. carinatus*; and partly upon a collection from the Telle River, obtained by Mr. Alfred Brown of Aliwal North, referred to *M. Browni*. The former is represented by cervical, dorsal, sacral, and caudal vertebræ; ilium, ischium, and pubis; femur, tibia; humerus, metatarsals, and phalanges. The latter is known from cervical, dorsal, and caudal vertebræ, femur, metatarsals, and bones of the digits. The affinities with *Zanclodon* are, in some parts of the skeleton, stronger than with *Euskelesaurus*. Part 7 gives an account of *Euskelesaurus Browni*, partly based upon materials obtained by Mr. Alfred Brown from Barnard's Spruit, Aliwal North, and partly on specimens collected by the author, with Dr. W. G. Atherstone, Mr. T. Bain, and Mr. Alfred Brown, at the Kraai River. The former series comprises the maxillary bone and teeth, vertebræ, pubis, femur, tibia and fibula, phalanges, chevron bone and rib. The latter includes a cervical vertebra and rib, and lower jaw. The teeth are stronger than those of *Teratosaurus*, or any known Megalosaurian. The anterior part of the head was compressed from side to side, and the head in size and form like *Megalosaurus*, so far as preserved. The pubis is twisted as in *Staganolepis* and *Massospondylus*, with a notch instead of a foramen at the proximal end, as in those genera; and it expands distally after the pattern of *Zanclodon*. The chevron bones are exceptionally long, and the tail appears to have been greatly elongated. The femur is intermediate between *Megalosaurus* and *Palæosaurus*, but most resembles *Zanclodon* and *Massospondylus*. The tibia in its proximal end resembles many Triassic genera; and in its distal end is well distinguished from *Massospondylus* by its mode of union with the astragalus. The claw-phalanges are convexly rounded, being wider than is usual in Megalosauroids. The lower jaw from the Kraai River gives the characters of the articular bone, and the articulation, as well as of the dentary region and teeth. The cervical vertebra is imperfect, but is remarkable for the shortness of the centrum, being shorter than in *Megalosaurus*. In Part 8 an account is given of *Hortalotarsus skirtopodus* from Barkly East, preserved in the Albany Museum. It is a Euskelesaurian, and exhibits the tibia and fibula, and tarsus. There is a separate ossification for the intermedium, which does not form an ascending process; and the astragalus is distinct from the calcaneum. The metatarsals are elongated, and the phalanges somewhat similar to those of *Dimodosaurus*. Part 9, in conclusion, briefly examines the relations of the Saurischian types with each other, and indicates ways in which they approximate towards the Ornithosauria. It is urged that the Ornithosauria are as closely related to the Saurischia as are the Aves to the Ornithischia; and that both divisions of the Saurischia approximate in *Staganolepis* and *Belodon*. Finally, a tabular statement is given of the distribution in space and time of the 25 Old World genera which are regarded as probably well established. Eight of these are referred to the Cetiosauria, thirteen to the Megalosauria, and four to the Aristosuchia or Compsognatha.—Mesosauria from South Africa, by Prof. H. G. Seeley, F.R.S.—On a new Reptile from Welte Vreden, *Eunotosaurus africanus* (Seeley), by Prof. H. G. Seeley, F.R.S. The President observed that there could be no question as to the great value of these papers, the first of which especially was the outcome of years of experience and study on the part of the author. It was only right to remark that the paper on Saurischia was received by the officers of the Society early in *April*. Since that date Prof. Marsh, in his notes on Triassic Dinosauria (which did not appear till *May* 24), had published, as regards *Zanclodon*, conclusions similar to those at which the author (Prof. Seeley) had already arrived. Mr. E. T. Newton also spoke. Prof. Seeley drew attention to a photograph of *Hortalotarsus*, a reproduction of a sketch made at Barkly East, before the original specimen had been destroyed in the process of blasting the rock.—The dioritic picrite of White Hause and Great Cockup, by J. Postlethwaite.—On the structure of the American Pteraspidian, *Palæaspis* (Claypole), with remarks on the family, by Prof. E. W. Claypole.—Contributions to the geology of the Wengen and St. Cassian strata in Southern Tyrol, by Maria M. Ogilvie, B.Sc. (Communicated by Prof. C. Lapworth, F.R.S.)—Notes on some new and little-known species of Carboniferous *Murchisonia*, by Miss Jane Donald. (Communicated by J. G. Goodchild.)—Notes from a geological survey in Nicaragua, by J. Crawford, State Geologist to the Nicaraguan Government (Communicated by Prof. J. Prestwich, F.R.S.)—Microzoa from the phosphatic chalk of Taplow, by F. Chapman. (Communicated by Prof. T. Rupert Jones, F.R.S.)—On the basalts and andesites of Devonshire, known as felspathic traps, by Bernard Hobson.—Notes on recent borings for salt and coal in the Tees salt-district, by Thomas Tate.

MELBOURNE.

Royal Society of Victoria, March 12.—Annual Meeting.—The following officers were elected for the year:—President: Prof. Kernot. Vice-Presidents: Messrs. E. J. White, H. K. Rusden. Hon. Treasurer: Mr. C. R. Blackett. Hon. Librarian: Dr. Dendy. Hon. Secretaries: Prof. Spencer, Mr. A. Sutherland.—The following paper was read:—Preliminary notice of Victorian earthworms: Part 2, the genus Perichæta, by Prof. Spencer. The author described 18 species collected in Victoria, of which 16 are new.

May 13.—The following papers were read:—On confocal quadrics of moments of inertia pertaining to all planes in space, and loci and envelopes of straight lines whose moments of inertia are of constant magnitude, by Martin Gardiner.—Further notes on the oviparity of the larger Victorian Peripatus, generally known as *P. leuckartii*, by Dr. Dendy. In this paper the author replied to some remarkable strictures recently passed upon his work by Mr. J. J. Fletcher in the Proceedings of the Sydney Linnean Society. He showed that at the time of writing his first paper on this subject nothing was known as to the method of reproduction of *P. leuckartii*, Mr. Fletcher's brief footnote to the effect that one specimen dissected was found to be pregnant not of necessity implying the presence of developed embryos within the egg-case. The Victorian specimens, containing in their uterus large eggs, might with equal truth be described as pregnant. Dr. Dendy brought forward evidence proving conclusively that in the eggs investigated by him development had gone on normally outside of the body for a period exceeding eight months, one of them at the close of this time containing a perfect young form with even the pigment developed. Since the publication of his first paper, but not prior to this, Mr. Fletcher had shown that the New South Wales *Peripatus leuckartii* was undoubtedly viviparous; and Dr. Dendy suggested that if, as seems most probable, the Victorian species is oviparous, then his original idea of its being a distinct species from the New South Wales form may probably be correct.

Paris.

Academy of Sciences, June 27.—On the local disturbances produced underneath a heavy load uniformly distributed along a straight line perpendicular to the two edges, on the upper surface of a rectangular beam of indefinite length laid down on a horizontal surface, or on two transverse supports equidistant from the load, by M. J. Boussinesq.—Contribution to the study of the function of camphoric acid, by M. A. Haller.—On the presence and the nature of the phylacogenic substance in the ordinary liquid cultivations of *Bacillus anthracis*, by M. Arloing. The liquid was carefully siphoned off from a large cultivation of the bacillus which had been allowed to stand for a considerable time. The usual porcelain filters were not employed, as they are apt to intercept most of the prophylactic substances. A liquid perfectly free from the anthrax bacillus having thus been obtained, two solutions in glycerine were prepared, the one containing the substances soluble in alcohol, the other those precipitated by alcohol. Of six lambs, two received subcutaneous injections of the former, two of the latter solution, and the rest of neither. Eight days afterwards all six were inoculated with a very virulent dose of the bacillus. The only survivors were those inoculated with the matter soluble in alcohol, thus proving that the prophylactic substance belongs to this group.—On the determination of the angle of polarization of Venus, by M. J. J. Landerer. By almost daily observations, extending from April 29 to June 8, the angle of polarization of Venus was found to vary between 45°·17 and 27°·51, using an instrument of 135 mm. aperture, to which a Cornu photo-polarimeter was adapted. The author concludes that the light from the crescent of Venus is not polarized, and hence that almost the entire visible surface of the planet is constituted by a thick layer of clouds. At the poles, however, permanent spots are observable, which are due to part of the solid surface protruding beyond the cloudy mass.—On the variations in temperature of water suddenly compressed to 500 atmospheres between 0° and 10°, by M. Paul Galopin. An account of the first of a series of experiments to be made in M. Raoul Pictet's laboratory to determine the heat produced by the adiabatic compression of a large number of liquids between − 200° and + 200°, under sudden variations of pressure amounting to 1000 atmospheres. The apparatus consists of a steel cylinder provided with a thermometer 1 m. long, capable of measuring 0°·01. Pressure is applied by means of a Cailletet pump, and the whole apparatus is immersed in a large calorimeter with quadruple envelopes. The results obtained, which vary from 0°·20 at 0°·4 to 0°·59 at 10°, show that the increase of pressure lowers the temperature of maximum density of water for that particular pressure, and that under high pressures it corresponds nearly to the freezing-point.—Measurement of the dielectric constant by electro-magnetic oscillations, by M. A. Perot. This measurement is based on the law formulated by Blondlot, according to which the period of the resonators is proportional to the square root of their capacities. The value obtained for essence of terebenthine was 2·25, that for ice between 60 and 71, in confirmation of previous results.—On the conductivity of a gas inclosed between a cold metal and an incandescent body, by M. Edouard Branly.—On the physiological effects of alternating currents with sinusoidal variations: process of administering them in electro-therapeutics, by M. A. d'Arsonval. The law indicated by the results of the experiments is that the intensity of the motor or the sensory reaction is proportional to the variation of potential at the point excited. Although oscillations of great frequency seem to have but faint physiological effects, a careful analysis shows that the absorption of oxygen and the elimination of carbonic acid in the lungs is greatly augmented.—On aluminium, by M. Balland. A series of experiments to prove that aluminium is well-suited for domestic utensils, being not more attacked by air, water, wine, coffee, milk, butter, &c., than other metals used for such purposes.—Action of chlorine on the alcohols of the fatty series, by M. A. Brochet.—On asboline (pyrocatechine and homopyrocatechine), by MM. Béhal and Desvignes.—On the vegetable cholesterines, by M. Gérard.—Researches on the adulteration of the essence of sandalwood, by M. E. Mesnard.—On two specimens of the waters of the Arctic seas, by M. J. Thoulet.—New remarks on "pœcilogony," by M. Alfred Giard.—On a sporozoarian parasite of the muscles of the Decapod Crustaceans, by MM. F. Henneguy and P. Thélohan.—The first phases in the development of certain nematoid worms, by M. Léon Jammes.—A contribution to the history of ambergris, by M. S. Jourdain.—On the *brunissure*, a disease of the vine caused by the *Plasmodiophora Vitis*, by MM. P. Viala and C. Sauvageau.—On the secretion of oxygen in the natatory vessel of the fishes, by M. Chr. Bohr.—Physiological action of mountain climates, by M. Viault. The effects of a high elevation, though powerfully beneficent for dyspeptics, neurasthenics, and tuberculous patients, must be long continued to be permanent. The effects are due to an increase in the number of blood corpuscles and in the respiratory power of the blood.—Permanent abolition of the chromogenic function of the *Bacillus pyocyaneus*, by MM. Charrin and Phisalix.

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THURSDAY, JULY 14, 1892.

A TREATISE ON ZOOLOGY.

Outlines of Zoology. By J. Arthur Thomson, M.A., Lecturer on Zoology in the School of Medicine, Edinburgh. (Edinburgh and London: Young J. Pentland, 1892.)

GENERAL.—The above-named volume of 604 pages small octavo, the latest of Pentland's "Students' Manuals," is divided into twenty-five chapters, with an introduction and a well-constructed index. By way of illustration, there are interleaved two-and-thirty sheets of diagrammatic sketches. It is difficult to find upon these any dozen figures which adequately represent anything in nature, and the majority of the "diagrams" are the rudest of rude sketch maps. Archetypes are well to the fore with their misrepresentations and evil influences, and such illustrations as those of the "unsegmented worm," the "spinal canal" figure of Plate 22, and others akin to them, are meaningless atrocities, conveying absolutely no idea to the mind. The Peripatus series are very suggestive; they are three in number—namely, one (bad) depicting the whole animal, another (worse) of a nephridium, and a third (unfounded) representing a conventional branched tube, spiral lining and all (*sic*). To be brief, the illustrations are mostly bad, and might well be dispensed with. Of those copied from well-known figures, many are spoilt in the copying, while the remainder are such as might have been produced in the greatest haste by a person accustomed to reading about, but not to handling, objects of the class delineated.

The book itself is written in a clear and intelligible style, and its author has been at immense pains in producing it. He deals with many difficult topics, especially when they do not involve minute structural detail, with conspicuous success. He is in some parts racy, in others flippant, *pace* the remark (p. 264) that "even a wooden leg may crumble before" the jaws of the termite; and he occasionally shows himself to be alive to difficulties of the passing moment—for example, that of the histogenesis of the nerve fibre. Some sections of the work are deplorably meagre, *e.g.* those devoted to the Ganoids, Tunicata, Rotifera, and Sponges, and especially to the Brachiopods and Polyzoa, which (following Lang) the author ranks with the Sipunculids and Phoronis as the "Prosopygii." Classifications such as that given of the Chelonia, and the adoption of the absolutely groundless term "Ornithosauria" as the ordinal name for the Pterodactyles, are bad examples of their kind. Akin to the occasional flippancy already alluded to are the descriptions of the embryonic membranes as "birth-robes," of the crystalline lens and the liver as "moored" to adjacent structures, and of the viscera as "swathed" in the mesentery. All science worthy the name must be now technical, whether set forth in the pages of a monograph or of a text-book; and when recognized terms are in daily use they should be employed. Personal names are occasionally mentioned; and it is a curious detail that, with one or two exceptions, those of workers in the Edinburgh School are alone qualified. We strongly deprecate the mention of individuals in an elementary text-book, as unnecessary and liable to abuse; but, in having adopted the course alluded to, the author displays a becoming respect for his seniors, such as we could wish were more general nowadays. His book is written for Edinburgh students; but we nevertheless note the absence of all reference to certain organisms in vogue among them—to wit, *Trochosphæra*, a knowledge of the development of which was demanded in a recent syllabus issued by authority.

The book, however, while lacking in much that is of primary importance, contains a bulk of excellent material. It is wonderfully free of really gross errors, and we therefore willingly recommend it on its general merits as a useful work of reference, believing that the author will strengthen its weaknesses as opportunity occurs.

The assertion that *Limnocodium* was "found in a tank at Kew" will probably whet the appetite of that establishment, and statements like that of the brain being "but an anterior expansion of the medullary canal," while self-explanatory, afford at least a relief to the reviewer.

Analytical.—The author tells us in his preface that his book is "intended to serve as a manual which students of zoology may use in the lecture-room, museum, and laboratory"; and, in accordance with this, he subdivides most of the chapters each into three sections, dealing respectively with what we presume he would consider a lecture equivalent, with the more didactic consideration of type-structure, and with facts usually embodying the principles of classification. A very ambitious scheme this; and it will be convenient to deal with each of the three departments separately.

First, as to the use of the book in the laboratory. The author here deals with familiar types, and supplements these here and there by the addition of wisely chosen species. His descriptions are, however, at most points insufficient and far too general, the one detailed account being made to do duty in the case of the Simple Ascidian (p. 358) for three distinct genera. This is not as it should be. The method of laboratory instruction in zoology employed in this country, with its rigid adherence to the type-system, is, in the long run, but that of teaching the alphabet whereby the student shall read; and, even were this not so, the laboratory training is one in discipline and observation, wherefore it is of the highest importance that any notes which shall be given the beginner for his guidance in it, shall be rigidly confined to actual statements of observed fact. The author partially disarms criticism under this head by remarking that his book is intended (preface) "as an accompaniment to several well-known works," which he cites (p. 88), and among which he enumerates leading laboratory treatises. Unfortunately, however, the plan of construction of those works does away with the necessity for his own as an adjunct to their utility. And we have therefore but to deplore the incorporation of generalities and ambiguities, in a portion of the author's treatise where they are calculated to encourage a general looseness, and to nullify much of the good intended by the founders of the system which he has adopted.

On passing to the two remaining departments of the book, we express ourselves at a loss to appreciate the utility of a text-book in the lecture-room. Much that passes current for scientific lecturing nowadays is mere parrot-work; and lecturing which is confined to mere text-book recapitulation (such as could alone justify the author's intention that his book should be used in the lecture-room) is no lecturing at all, but rather a poor form of dictation work. We deem it the highest aim of a scientific lecturer to teach his hearers, by example, how best to extend, systematize, and apply their knowledge of crude facts previously acquired in the laboratory. He should in all cases work out from these and lead up to generalizations; and, to the end in view, he should be up to date in his reading, and, above all, cautious in his selection of approved topics. Given this line of action, the competent teacher could not fail to present his facts in a manner in which they could not be found in any text-book. The author of the work before us has clearly realized this position, and much of his book which we presume he would regard as the equivalent of lecture material, fulfils our ideal. We note, however, a too frequent want of judgment, and a too general desire to present theories before facts. By way of example, the inter-relationships of the Echinodermata are summarily dismissed in some ten or a dozen lines, in a manner as "cocksure" as it is certainly erroneous; and the beginner is told (p. 377) that the ribs of Vertebrates "perhaps bear the same relation to the vertebræ that the visceral arches do to the skull," before he either knows sufficiently what constitutes a rib, or at all appreciates the difficulties in the way of homologizing the ribs of the leading classes of Vertebrata. And here and there the author goes out of his way to raise difficulties at the outset (*e.g.* the opening sentence in the book, and the second sentence of p. 121), when dealing with terms having a definitely accepted meaning; while, in ushering in the Mollusca with a reference (p. 299) to "a diagrammatic summary of the chief anatomical characters" and a "schematic Archi-mollusk—a reconstruction of a possible ancestor," he proceeds along a line subversive of all good discipline established either on precedent or sound sense. There is here evidence of a topsyturveydom in method, which could only be productive of disastrous results.

Concerning the more strictly text-book portion of the volume, we confess to a similar attitude of mixed judgment. There is in it much that is admirable and beneficial, and not a little that is crooked and injurious. The gastræa theory is swallowed outright, mention of equally plausible alternative ones being confined (p. 62) to five none too fortunate lines. The description of the scapula (p. 472) as "a membrane bone," of the cranial nerves of vertebrates (p. 381) as ten in number; like the assertions (p. 444) that "it is very difficult to distinguish Amphibians from Fishes," that (p. 33) Volvox "is a hollow sphere of epithelium," that the skate's egg-purse is (p. 425) "composed of a horny substance allied to that of hair and hoof"; like definitions such as that of *Balanoglossus* and *Cephalodiscus* (p. 348) as "surviving incipient Vertebrates" (of course with a "notochord"), of *Lepidosiren* (p. 428) as "only a species of *Protopterus*," simply will not do; while arrangements such as those of the Mammalia (p. 7) and Vermes (p. 149) are hardly in keeping with modern conceptions.

Retrospective.—On retrospective examination of the book before us, we seek in vain for evidence of that impress of the author's individuality as an actual worker which has so often "made" the zoological text-book of the past. The author has been too content to abstract all in his way. Obsolete classifications are placed side by side with others as audacious as they are premature, and rival theories are alike abstracted for what they may be worth. When, however, the author's method leads to the citing (p. 86) of Kropotkin as an authority on evolution; to the placing side by side, as alternative interpretations of the phenomena of Nature, those generalized statements of facts which constitute the "laws" of Darwin, and the flighty fantasies shot at a venture by certain younger "law-makers" (some of whom are sufficiently candid to admit that they are generalizing without facts), willing to risk all if, perchance, a frivolous public will but proclaim them philosophers, the experienced naturalist, in whose hand the judgment lies, steps in and demands a reconsideration. In a word, the author has insufficiently exercised his judgment in selection of material. To the teacher of science the duty of showing his scholars, by inference, what to neglect is, perhaps, of paramount importance to that of indicating upon what they are to rely. The author of the volume under review would, however, leave the discretion in the hands of the student; he writes rather as the amateur, to whom everything is equally important, and in thus acting he fails to recognize one of the highest functions of his office, to the utter confusion, if not the ruin, of his followers. In our opinion, his book, although in many respects admirable, falls short in each of its great departments which we have signalized. It will be largely used, and we wish it an ultimate success. It nevertheless contains the framework of a really serviceable text-book; and if the author will elaborate this, using a fitting exercise of judgment, and either eliminating the illustrations altogether or replacing them in others better and more numerous, he ought to produce a work of more than passing value, and he would sufficiently justify the great pains at which he has placed himself. In its present form the book is calculated to encourage a love of premature generalization, and anyone adopting its methods would teach fantasies before facts. The mental attitude which it typifies is one apt to create a bias, under which the student would suffer in his after work, as is indeed exemplified by the author himself in his treatment (pp. 178–79) of the reproductive organs of the worm. To encourage this is but to foster a growing evil. The didactic method of instruction in zoology now in vogue will unmistakably prevail in the future; but, unless its dryness be salted with work akin to the good old-fashioned field work, to the discouragement of the more modern and pedantic phylum-mongering and striving after impossibilities, better, by far, the *régime* of the past.

G. B. H.

WATTS' "DICTIONARY OF CHEMISTRY."

Watts' Dictionary of Chemistry. Vol. III. By Forster Morley and M. M. Pattison Muir. (London: Longmans, 1892.)

THE third of the four volumes of this excellent work has just appeared, and in value and interest this one does not stand behind the two previous volumes.

Amongst the articles written by eminent specialists, one, the most important, is that contributed by Prof. J. J. Thomson, of Cambridge, on the theories of the molecular structure of bodies. It is from the interpretation of chemical phenomena, by the help of exact physical research, that we may most hopefully look for insight into the true explanation of these phenomena. And although the theory of the molecular constitution of matter now universally held has been adopted as regards chemical change ever since the publication of Dalton's new system of chemistry in 1808, the crucial proof of its necessity has only recently been given. Prof. Thomson briefly but clearly explains the historical development of this proof. The first attempt was made by Cauchy, founded on the dispersion which light experiences when it passes through transparent bodies. But this attempt was an incomplete one, and a less ambiguous proof was given by Osborne Reynolds in 1879, based upon the thermal effusion of gases. Lord Kelvin, Loschmidt, and others have gone still further, not only proving that matter possesses structure, but giving limits below which the "coarse-grainedness" of matter cannot lie. These conclusions are founded upon considerations of several distinct sets of phenomena, viz. surface-tension, the difference of potential which occurs when two metals are placed in metallic connection, the amount of polarization at the surface of an electrode and of an electrolyte, and the viscosity, the diffusion, and the conductivity for heat, of gases. The discussion of the methods by which the limit is reached in the case of surface tension is next clearly given, and the result arrived at that a thickness of 10^{-8} cm. must be comparable with the range of molecular action of the water molecules. The results of the well-known researches of Quincke on silver films and on capillary elevation, as summarized in a lecture delivered before the Chemical Society of London by Prof. Rücker in 1888, are then explained, and the limits of molecular action deduced from these experiments. Having given an idea of the coarse-grainedness of matter, Thomson proceeds to consider the various theories of that structure, and gives an account of the most important of these by Lord Kelvin and Lindemann. The evidence of molecular structure afforded by the spectra of bodies, that concerning the arrangement of the atoms in the molecule on the supposition that the atoms are vortex-rings, and the electrical theory of molecular structure, first brought forward by Helmholtz in his Faraday Lecture, are all clearly discussed; and the author's own researches on the conduction of electricity by gases, which bear out the results of this latter theory, are adverted to. The whole article, which only extends over seven pages, forms an admirable exposition of a most important, if a somewhat difficult, subject, and shows what chemistry gains from the work of mathematical physicists.

Another short but excellent article is that by Mr. Shenstone, on ozone, including, as it does, the most recent work on the subject, as well as a *résumé* of the older and better known results. The question as to the relation existing between the quantity of ozone produced and the potential difference between the discharging surfaces, does not appear to have as yet been settled, though Berthelot finds that an increase of potential produces an increased yield of ozone. Nor has the exact influence of temperature and pressure been properly made out, though it appears that at a pressure of about 50 mm. ozone is alternately produced and destroyed. These facts point to the conclusion that, although much labour has already been spent upon the investigation of ozone, much yet remains to be accomplished before our knowledge of "modified oxygen" is anything like complete.

Of the recent progress made in our general chemical conceptions, none are of greater, if any are of as great, importance as the foundation of the periodic law by Mendeleeff in 1869. A Dictionary which failed to give an account, not only of the nature of this law, but also of its rise and development, would indeed be incomplete. Mr. Douglas Carnegie's article, however, does justice to his subject, and I am glad to see he has not ignored the extensions made by my lamented pupil and friend, Carnelly, which are truly said to be as much in advance of the earlier views of Dumas and Gladstone as the periodic law is in advance of the earlier disconnected schemes of classification. And I agree with the writer in his remarks that if these extensions must be regarded as bold speculations, they indicate the direction in which investigations on the *rationale* of the periodic law, and of the nature of the elements, will probably have to be prosecuted before we can hope to arrive at any explanation of the law, or of the nature of the chemical elements themselves.

The article on "Metals (rare)" is, of course, contributed by Mr. Crookes. It contains an account of the contributor's own researches on the splitting up of the rare earth metals. Many of the metals described in our treatises, and in the Dictionary itself, are probably mixtures. Some years ago I proved that an element termed philippium was in reality a mixture of two others, viz. terbium and yttrium, and Mr. Crookes's researches have since confirmed my results. It is, however, quite true, as Crookes observes, that until we know what terbium and yttrium themselves are, we have not got to the bottom of the question. And from his own work it does not appear very likely that the chemists of this generation will bottom this subject, for the more Mr. Crookes works on the separation of these bodies the more complex does the question of identification appear to become. Those who wish to form an idea of the character of work of this kind will do well to study the article.

A notable characteristic of this Dictionary is the summation of the properties of the different allied groups of chemical elements. Thus in this volume we find an excellent article by one of the editors, Mr. Pattison Muir, on the nitrogen group of elements. The relationships between the corresponding compounds of two different members are clearly set forth in tabular form, and thus the reader is able at a glance to compare the analogies and differences which these compounds exhibit both in composition and properties.

Prof. Armstrong's article on isomerism bears out the author's reputation for clear statement and complete knowledge of his subject. He fully discusses its historical development, strengthening his statements by valuable quotations from the writings of chemists of eminence, and brings the matter up to the latest views of chemists such as Van't Hoff, Victor Meyer, Wislicenus, and others, who have recently contributed to our knowledge of isomeric bodies.

For the rest, which indeed forms the bulk of the volume, I must content myself with saying that the numerous articles descriptive of organic compounds, ranging from indin on p. 1 to phenyl-tetrazole carboxylic acid on p. 858 (not to mention the inorganic compounds) are mainly contributed by Dr. H. Forster Morley, one of the editors. How far these hundreds of compounds are adequately described, or what mistakes of omission or commission the descriptions may contain, or how many printers' errors exist, must be left to be determined, if determined at all, by someone with more leisure, and, may I add, with more taste for that sort of work than I possess. But I may conclude by saying that, knowing the accuracy and care which uniformly characterize Dr. Morley's work, I do not think that any adverse critic, if such there should be, of this great addition to our chemical literature, will find it a very happy hunting-ground, for, as far as I am able to judge, the work has been carefully and accurately done. H. E. ROSCOE.

THE ENGLISH SLÖJD.

Manual Instruction; Wood-work; the English Sloyd. By S. Barter. With 302 Illustrations. Preface by George Ricks, B.Sc.Lond. (London: Whittaker and Co., 1892.)

IT is to be regretted that the author of this very excellent and practical work should not have stated on the title-page what it really is, *i.e.* a book simply teaching carpentry, including directions for a limited amount of technical or mechanical drawing, and not have termed it "Wood-work," since by this term much is understood which is not given in his pages. Neither is there any occasion for the word which he gives in one place as *Sloyd* and in others as *Slöjd*, it being sufficiently misused already in Swedish by being confined to common incised carving and small carpenter's work, when it is properly applicable to all kinds of technical art. Since Mr. Barter has had the intelligence and boldness to declare that whatever can be done with the barbarous "*Slöjd*" knife can be better done with the chisel, it is to be regretted that, as he is with his English common-sense altogether out of and beyond *Slöjd*, he did not let the Swedish system alone altogether. There was no occasion for him to mention it or its palpable defects, to which he might have added the preposterous arrogance of its claims to be the incarnation of all that is needed to train the hand and eye to industrial art. However, since he who is fitter to be the leader humbly assumes the name, and follows the lead as an English *Slöjder*, we, of course, cannot complain, since it is to his own disadvantage that he assumes a title which detracts seriously from the merits of the treatise. He gives a very good introduction on drawing, which has, however, the serious defect of being beyond the capacity of mere boys, who, while at carpenters' work, certainly cannot be expected to devote hours to learning the meaning and application of "orthographic projection," "the assumption of the existence of parallel horizontal rays of light which project the elevation on a vertical surface," "isometric axes," and "therefore as AC is to $CH :: \sqrt{3} : \sqrt{2}$; but $CH = A'K$, which is," *et cetera*—all of which, with the diagrams, contrasts strangely with the pictures of the ten-year-old chubby youngsters who are represented as merrily sawing and planing in the frontispiece. It is true that there are little boys who can master Euclid, or its equivalents; but an experience of years in teaching qualifies us to state that a much more simply written chapter than this, or one within the ready comprehension of "boys," would have been better adapted to the book. The forty-two pages devoted to timber are thoroughly scientific, practical, and admirable. Yet as boys seldom have any great choice of wood, and have little to do with teak, ebony, and lignum vitæ, much of the space might have been better devoted to some kind of wood-work not touched on in this book. Materials and tools are well described. We observe that in his illustrations of nails Mr. Barter makes no mention of the very best of all—the triangular, which goes home as straight as a screw, and holds like one.

"Bench-work" is the best portion of the book, being thorough, comprehensive, and manifestly written by a master of the subject. It is not beyond the comprehension of an intelligent boy who will devote to it serious attention; therefore, for such as are somewhat advanced, it may be warmly commended, for the simple reason that intelligent minds pay most serious attention to, and remember best, what costs them some trouble. The author is evidently a very practical, serious, and earnest mechanic, who, understanding his business perfectly, describes everything as he would teach it to a class of young men who had been a while in workshops. But with his "orthographic projections" as with his whole style, he is—not invariably, nor even generally, but very often—too hard for urchins; and, in fact, the juvenile who is depicted on p. 175 as boring a hole has appropriately the pensive air of one who is very much bored himself—probably by some difficulty in the text. Yet all of this does not detract from the fact that the work is an admirable one, that it is the best of its kind, and perfectly adapted to the use of teachers establishing classes, who are, after all, the only persons who really need or read such works, as pupils seldom look at anything of the kind unless required to. But though it is very seldom done, it would have good results if pupils in technical schools should be made to read more, and secondly, if the teacher should carefully explain to them the text.

An excellent feature in the bench work is that the author, giving the names of a majority of such objects as an amateur may expect to make, describes in detail, with excellent and abundant illustrations, how to make them. He might in some cases have gone a little further in his work. Thus it never appears to have occurred to him that parquetry, or inlaid work, can be made save by sawing out pieces of wood in their natural colours. But a large portion of French and Italian work is made by using wood which is artificially coloured, and we should not have expected this to be passed over by a writer who had the intelligence to remark that "Colour, which plays so prominent a part in design, is entirely overlooked in he Slöjd system," which it certainly is, and with it much more that is indispensable to teaching the minor arts as a system even to the youngest children. Nor does Mr. Barter mention the so-called Venetian *intarsiatura*, in which the pattern, drawn on one piece of wood, is cut half through the panel, the line being then filled with coloured mastic, and the pattern dyed. But such sins of omission are trifling, though in a book which proclaims on its title that it is devoted to wood-work we should have expected something more than carpentry, and at least a full description of Slöjd carving. And having pointed out, as in conscience bound, every defect, we feel it to be a duty to congratulate the publishers of this remarkably handsome, well-bound, and useful work on having done their best, and on having issued a manual which deserves a place in every industrial school.

But there is a word to be said as regards the preface and a portion of the introduction. It is perfectly true that manual instruction for children develops their intellects, and fits them for life far more than ordinary school studies usually do. But it is not true that this training should consist, as Messrs. Ricks and Barter virtually declare, of nothing but Slöjd, be it Swedish or English, or of carpenters' work. Such training should be for girls as well as boys, and it should be based on design and drawing, taught simultaneously in the simplest and easiest freehand; after which the pupils may take up not merely carpentry, or even Slöjd—which is nothing effectively but a minor branch of wood-carving—but also wood-carving itself, and many other arts, all of which come as one and promptly to the pupil who can design, and, when occasion favours, also can model a little. But to expect that carpentry alone, without a trace of art, is all that is needed to inspire the creative faculty is a great mistake; and what is worse is that, despite thousands of living examples of the superiority of the more artistic method for children, the British—like the American—public persists in believing that all that is needed is to teach "our boys" how to make benches and boxes.

OUR BOOK SHELF.

Thermodynamische Studien. Von J. Willard Gibbs, übersetzt von W. Ostwald. (Leipzig: Engelmann, 1892.)

THIS is a German translation of three of Prof. Gibbs's Thermodynamic Papers. These were published during the years 1873-8, in the Transactions of the Connecticut Academy (vols. ii. and iii.); and one reason which prompted Prof. Ostwald to undertake the translation of them was their inaccessibility to the general scientific public. Their importance is sufficiently attested by the fact that part of the ground covered by Prof. Gibbs has been gone over again by later writers who deemed they were themselves pioneers.

"Graphical Methods in the Thermodynamics of Fluids" is the title of the first paper. It gives for the first time a general account of the comparative advantages of using various pairs of the five fundamental thermodynamic quantities for graphical representation. The entropy-temperature and entropy-volume diagrams are discussed in considerable detail. The second paper contains the description of the volume-energy-entropy surface, which generally goes by the name of Gibbs's thermodynamic surface. Its contents are familiar to all who have studied Maxwell's "Theory of Heat."

The third paper, "On the Equilibrium of Heterogeneous Substances," fills five-sixths (344 pages) of the whole book, and is, out of question, by far the weightiest contribution which Prof. Gibbs has made to the development of thermodynamic methods. To him must be given the credit of first formulating the energy-entropy criterion of equilibrium and stability, and developing it in a form applicable to the complicated problems of dissociation. To give anything like a complete idea of the contents of this paper, with its discussion of critical points, capillarity, growth of crystals, electromotive force, &c., would mean the reproduction of Prof. Gibbs's own very full synopsis, which in the German translation forms the greater part of the table of contents of the book. It will suffice to notice the general theory of the voltaic cell, with which the paper ends. Here distinctly for the first time is it pointed out that the electromotive force of the cell depends on other factors than the variations of its energy. Von Helmholtz's theory, which differs from that given by Prof. Gibbs only in the greater fulness of detail, was not published till 1882.

Prof. Ostwald tells us that he had the benefit of the author's revision. With the exception of a few obvious corrections the original papers are most faithfully reproduced, even to certain footnotes which in these days have no particular value. In the circumstances a little license might well have been taken, and a slavish adherence to the original text departed from. For example, it is surely most desirable to use the word *isenergic* for lines of equal energy, and not the inappropriate term *isodynamic* which Prof. Gibbs made use of in his paper of 1873. Again, we question the right of any writer on thermodynamics to use the word *reversible* in other than Carnot's sense. Such double meanings tend to produce confusion, in spite of elaborate footnotes.

These blemishes apart, however, there is no doubt that Prof. Ostwald deserves great credit for his labour of love in preparing this translation. He has made it possible for the many, who know of Prof. Gibbs's work only at second hand, to acquaint themselves with the original papers, and we feel confident that the book will find its place on the shelves of all who desire a really complete library of thermodynamic literature.

Elements of Physic. By C. E. Fessenden. (London: Macmillan and Co., 1892.)

THE subject matter of this book is arranged in four chapters—Matter and its Properties, Kinematics, Dynamics (including statics, hydrostatics, and pneumatics), and Heat. It thus forms an excellent introduction to a more extended study of physical science. The treatment of the subject is based largely on simple experiments to be performed by the student himself, whose reasoning powers the author seeks to draw out as far as possible by suggestive questions interspersed through the text. The following example will give a good idea of the style of treatment:—

". . . All experience teaches that *no two portions of matter can occupy the same space at the same time.* This property which matter possesses of excluding other matter from its own space, is called *impenetrability.* It is peculiar to matter, nothing else possesses it. These facts being known, let us proceed to put certain interrogations to nature. Is air matter? Is a vessel full of air a vessel full of nothing? Is it 'empty'? *Can matter exist in an invisible state?*

"*Experiment* 1.—Float a cork on a surface of water, cover it with a tumbler, or tall glass jar, and thrust the glass vessel, mouth downward, into the water. . . . State *how* the experiment answers each of the above questions and what evidence it furnishes that air is matter, or, at least, that air is like matter.

"*Experiment* 2.—Hold a test tube for a minute over the mouth of a bottle containing ammonia water. Hold another tube over a bottle containing hydrochloric acid. The tubes become filled with gases that rise from the bottles, yet nothing can be seen in either tube. Place the mouth of the first tube over the mouth of the second, and invert. Do you see any evidence of the presence of matter? Was this matter in the tubes before they were brought together? If not, from what was it formed? Which of the proposed questions does this experiment answer? How does the experiment answer it?"

In many cases the questions asked are beyond the powers of the average beginner to answer, but this is not a serious objection if the book is used, as seems to be intended, for class instruction in schools. For such use it is admirably well adapted. Numerous questions and examples are scattered throughout the text; in the sections of kinematics and dynamics geometrical treatment alone is adopted, the student being supposed to be acquainted with Euclid but not with trigonometry.

The style is concise, but clear and accurate, and as the book has not been written with the view of preparing the student for any special examination it is refreshingly free from any tendency towards cram. H. H. H.

Recette, Conservation, et Travail des Bois. Par M. Alheilig. (Paris: Gauthier-Villars et Fils, 1892.)

THIS little book belongs to the useful series entitled "Encyclopédie Scientifique des Aide-Mémoire." The author presents a remarkably clear summary of the principal facts relating to wood, regarded from an industrial point of view. Although iron and steel have to so large an extent taken the place of wood in various great constructions, wood is still, of course, needed in vast quantities, and instruction in the proper way of dealing with it for industrial purposes must always form an important department of technical education. M. Alheilig has supplied a good text-book, the most valuable characteristic of which is that its practical details rest on a sound basis of scientific principle. He is especially successful in the chapters on the tools and machinery used in the working of wood.

Country Thoughts for Town Readers. By K. B. Baghot de la Bere. (London: Simpkin, Marshall, and Co., 1892.)

THE greater part of this book consists of imaginary conversations between a Canon and "a city lawyer," who spends two days with him in the country. The Canon lectures his friend with an air of authority and patronage which would not be particularly agreeable to ordinary mortals. The city lawyer, however, is never tired of thanking the great man for the knowledge he communicates. The Canon's information is made up chiefly of scraps of scientific commonplace, which, if they can be of no particular service to any class of readers, are at least harmless.

A Synoptical Geography of the World. (London: Blackie and Son.)

NO effort has been made by the compiler of this handbook to present geography in an attractive form. The volume consists of a number of bald statements which, as here given, could neither excite interest nor form any real addition to knowledge. It is not intended, however, that the book shall be used apart from other means of instruction. It is meant to be taken "in conjunction with a fuller text-book or the teacher's lectures." Used in this way it may be of some service to students in the revision of their work before examination. A good many maps have been specially engraved to accompany the text.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

An Acoustic Method whereby the Depth of Water in a River may be measured at a Distance.

ABOUT two years ago, I wished to know from time to time the rate at which a river was rising after a fall of rain. The river was at a considerable distance from the spot where its height was to be known. By means of the combination of two organ pipes, and a telephonic circuit, described in the following lines, I have been able to make the required measurement within rather close limits. At the river station, an organ pipe was fixed vertically in an inverted position, so that the water in the river acted as a stopper to the pipe, and the rise or fall of the water determined the note it gave, when blown by a small bellows driven by a very small water-wheel. A microphone was attached to the upper end of the organ pipe; this was in circuit with a wire leading to a town station at some distance; at the town station there was an exactly similar organ pipe, which could be lowered into a vessel full of water while it was sounding. By means of the telephone the note given by the pipe at the river was clearly heard at the town station; then the organ pipe at this station was lowered or raised by hand until it gave the same note. The lengths of the organ pipes under water at the two stations were then equal, so that the height of the water in the distant river was known.

The determination can be made in less than a minute by any one who can recognize the agreement of two similar notes. The arrangement when first tested was so placed that the height of water at two places near together might be easily compared. I found that a lad with an average ear for musical sounds was able to get the two heights to agree within one-eighth of an inch of each other, while a person with an educated ear adjusted the instrument immediately to almost exact agreement. The total height to be measured was 17 inches. A difference of temperature at the two stations would make a small difference in the observed heights. For example, taking a note caused by 250 vibrations per second, a difference of 10° C. between the temperatures of the two stations (one not likely to occur) would make a difference of about 0·02 feet in the height, a quantity of no moment in such a class of measurements. The organ pipes were of square section, and made of metal to resist the action of the water.

FREDERICK J. SMITH.

Trinity College, Oxford, June 28.

Waterspouts in East Yorkshire.

ON June 9, 1888, a waterspout was seen traversing the Yorkshire wolds in the neighbourhood of Langtoft, which finally spent its fury on the north-eastern side of a large basin-like range of valleys, where a steep declivity barred its further progress. A single cutting or trench was made in a slight hollow of the hill, and in this three large holes were scooped out of the chalk, which was here composed of much rubble, about seven feet in diameter and depth.

On July 3 of the present year, another waterspout has been developed, and has again expended its energy on the same hill as the previous one in 1888, a few yards only further south of the former site, and, taking a trifle more easterly course, has cut three parallel ditches or elongated pits in the solid chalk, two of them twenty to thirty yards in length, and seven to ten feet deep in the deepest portions, scattering the whole of the expelled rock, amounting to many tons, to the foot of the hill.

Serious floods were consequent, and the village of Langtoft, which is situated lower down the valley, was terribly inundated with a volume of water seven to ten feet in height, an immense amount of damage being done, including the total demolition of two cottages and a workshop. Fortunately no lives were lost beyond several pigs, sheep, and a few hundred fowls.

Driffield, July 9. J. LOVEL.

On the Line Spectra of the Elements.

PROF. STONEY seems to agree with me that I have given an obvious example of a motion for which the theorems in chapter iv. of his memoir do not hold good. Theorem B, page 591, runs thus: "Any motion of a point in space may be regarded as the co-existence and superposition of one *definite* set of partials which are the pendulous elliptic motions determined as above, &c." It is indeed obvious that a uniform motion in a straight line cannot be regarded in this manner, not even approximately for any length of time, if the set of partials are required to be *definite*. I might have given an example of a limited motion, *e.g.* $x = \sin t^2$, which equally contradicts the theorem, but I thought a more obvious example would convince Prof. Stoney more easily. I think, indeed, that the reasoning in chapter iv. of his memoir is erroneous. But I do not say that therefore Prof. Stoney's views on the cause of the line-spectra are wrong. They may be right, although the argument in chapter iv. is not. Why this criticism is not legitimate I do not see. For no slight alterations or additions would set those theorems right, as there is a palpable mathematical error at the bottom of it.

Technische Hochschule, Hanover, July 9. C. RUNGE.

The Grammar of Science.

THE exposition of the Newtonian laws as given by Thomson and Tait has unfortunately been taken as the basis for the treatment of the laws of motion by all elementary text-book writers in the English tongue since the publication of the great "Treatise on Natural Philosophy." When that exposition is attacked we are told that Newton introduced a qualifying context which has been omitted from the exposition. In other words the current statement of elementary dynamical principles is thrown overboard in favour of Newton pure and simple. On the other hand when Prof. Tait uses an expression which is totally opposed to that principle of the "subjectivity of force" which C.G.K. claims that Prof. Tait was the first, or among the first, to propound, we are told that this expression was obviously suggested by "Newton's own anthropomorphic language." C.G.K., I take it, admits that the Newtonian Laws of Motion are illogical and unphilosophical when stated by Thomson and Tait without Newton's modifying context. I propose therefore to shortly publish a criticism of the laws of motion as accompanied by that context of Newton's which does not appear in Prof. Tait's text-books. I trust C. G. K. will not then turn round on me and say, "Oh, yes, but this has nothing to do with Prof. Tait; it is Newton's own anthropomorphic language."

Lastly, as to the origin of the doctrine of the "subjectivity of force," which to my mind is just as much or as little valid as the "subjectivity of matter," I would remind C. G. K. that the first two parts of Kirchhoff's "Mechanik" were published in 1874, and were then only the publication of lectures of an earlier date. Philosophers before Kirchhoff taught the doctrine of subjectivity, but he, and not the author of the "Dynamics of a Particle," was the physicist who first helped many of us out of the mental obscurity as to dynamical principles produced by our study of the expositions of the laws of motion due to the Edinburgh school. KARL PEARSON.

"Are the Solpugidæ Poisonous?"

IN reference to this question, propounded by Mr. Bernard in your last issue, I should be inclined to answer in the negative. I captured several specimens of *Solpuga chelicornis* in the Transvaal, and on one occasion witnessed a persistent attack made on this "spider" by a bird which appeared to be the Cape wagtail (*Motacilla capensis*). Had the *Solpuga* possessed poisonous qualities the attack would probably not have been made.

The specimens taken by myself exhibited no signs of pugnacity, but always sought refuge in headlong flight to the nearest cover. W. L. DISTANT.

Russell Hill, Purley, Surrey, July 8.

Hairlessness of Terminal Phalanges in Primates.

I OBSERVE that, in your report of the proceedings of the Zoological Society, you allude to my paper on "a seemingly new diagnostic feature of the order Primates," viz. that the terminal phalanges are destitute of hair.

Since the paper was read I have found that this feature is not of ordinal value. But it is of sufficiently general occurrence to merit inquiry touching its distribution in different species.

Therefore I have withdrawn publication of the paper for the present. GEORGE J. ROMANES.

Oxford, July 1.

Mental Arithmetic.

REFERRING to the articles on "Mental Arithmetic" in NATURE, vol. xlv. p. 78 and 198, I beg to state that there also exists a very clearly written little text-book on arithmetic founded entirely on the principles mentioned by Mr. Clive Cuthbertstone. The title is "Neuer Unterricht in der Schnellrechen-Kunst," by C. Jul. Giesing, Editor, Carl Schmidt, in Doebeln (Saxony). Price 1 mark 80 pf. G. DAEHNE.

Dresden-Blasewitz, "Isis," July 9.

Jackals.

THE incident of the jackals entering Howrah brings to my memory that this winter jackals entered the suburban town of Bournabal, in the Smyrna district of Western Asia Minor. This last winter being severe, it was noticed in the papers that rabies had extended to wolves and jackals, and to this circumstance was attributed their entering the villages and attacking people, and also their attacking the domestic animals.

HYDE CLARKE.

WEIGHT.

THE following remarks are presented with the object of reducing the increasing gap which is growing between the treatment of the fundamental ideas of Dynamics, as taught in our academical text-books from the standpoint of verbal abstraction, and the ideas and language of those who have to deal with the actual phenomena of Nature as a reality.

1. According to the precise legal definitions of all our successive Acts of Parliament on "Weights and Measures," the *weight* of a body is the quantity of matter in the body, as measured out by the operation of weighing it in the scales of a correct balance.

The body to be weighed is placed in one of the scales, and is equilibrated by standard lumps of metal, stamped as pound weights, or kilogramme weights, or hundred weights, or ton weights, and the sum of these weights is called the *weight* of the body.

In the words of the Act of Parliament, 18 and 19 Victoria, c. 72, July 30, 1855, the British pound weight is defined as a weight of platinum, marked P.S., 1844, 1 lb., deposited in the Office of the Exchequer; and the Act goes on to say that this lump of metal "shall be the legal and genuine standard measure of weight, and shall be and be denominated the Imperial Standard Avoirdupois Pound, and shall be deemed to be the only standard of weight from which all other weights and all other measures having reference to weight shall be derived, computed, and ascertained, and one equal seven thousandth part of such pound avoirdupois shall be a grain, and five thousand seven hundred and sixty such grains shall be and be deemed a pound troy."

In defining the unit of length, the standard yard, the temperature must be defined, 62° F. in the Act of Parliament; but in defining the pound weight, there is in the Act no mention of temperature, height of barometer, height above sea-level, latitude, longitude, date and time of day, establishment of the port, &c., or of any other cause tending to alter the local value of g.

Details of the temperature and density of the air are only required when defining the volume of the gallon of 10 lbs. of water, or when making accurate copies of the standard platinum pound weight in some other metal—brass or iron, for instance—when a correction for the buoyancy of the air must be made; and it is to cover this detail that the words *in vacuo* have been added in the most recent Acts of Parliament on "Weights and Measures" (41 and 42 Victoria, 1878).

2. We now pass on to the investigation of the motion set up in a body of given weight due to the action of specified forces; we use the word *weight* advisedly, so as to agree with the terminology of the Acts of Parliament.

As the field of force in which we live is that due to the attraction of the Earth, it was natural to begin by taking the attraction of the Earth on our standard weight as the unit of force; and we find that in all Statical problems of architecture and engineering the unit of force employed is the force with which a pound weight, or a kilogramme weight, or a ton weight, is attracted by the Earth.

The engineer calls these forces the force of a pound, of a kilogramme, or of a ton; he does not add the word weight, reserving the word *weight* to denote the quantity of matter in the body which is acted upon, in accordance with the language of the Act of Parliament on "Weights and Measures."

In the Dynamics of bodies on the surface of the Earth, the same gravitational unit of force is universally employed in practice; and now, to take a familiar problem, we may investigate the motion of a train, weighing W tons, on a straight level railway, pulled by an engine exerting a tractive force of P tons, by the bite of the driving wheels on the rails.

Neglecting passive resistances, and the *rotary inertia* of the wheels, the train will acquire from rest a velocity v feet per second in s feet, given by

$$Ps = \frac{Wv^2}{2g} \text{ (foot-tons).}$$

The velocity growing uniformly, the average velocity will be half the final velocity v; so that if the train takes t seconds to go the first s feet,

$$s/t = \tfrac{1}{2}v,$$

and

$$Pt = \frac{Wv}{g} \text{ (second-tons).}$$

The word *second-tons* has been formed by analogy with the word *foot-tons*, to express the product of a force of P tons and t seconds, the time it acts; just as foot-tons expresses the product of a force of P tons and s feet, the distance through which it acts.

While Ps, the *work* in foot-tons done by the force P tons acting through s feet, has a mechanical equivalent, $\frac{Wv^2}{2g}$, called the *kinetic energy* of the train in foot-tons; so Pt, which we may call the *impulse* in second-tons of the force P tons acting for t seconds, has a mechanical equivalent $\frac{Wv}{g}$, the *momentum* communicated to the train in second-tons.

We merely state these theorems, with the addition of the proposed new name of *second-tons*, as these theorems are found in all dynamical treatises, being direct corollaries of Newton's Second Law of Motion.

We have measured W and P in tons, as would be natural in any railway-train problem, but the same equations of course hold when W and P are given in cwt., pounds, kilogrammes, or grammes; and then impulse or momentum will be given in second-cwt., second-pounds, second-kilogrammes or second-grammes; while work or kinetic energy will be given in foot-cwt., foot-pounds, or metre-kilogrammes, or centimetre-grammes, on changing to the metre or centimetre as metric unit of length, and changing at the same time the numerical measure of g.

3. The presence of g in the denominator of W in the dynamical equations will be remarked, and this constitutes a difficulty to the student, which our teachers of Dynamics have done their best to obscure.

The quantity g makes its appearance, not because W/g is an invariable quantity, as is generally taught, but because the unit of force in which P is measured is variable, being proportional to the local value of g.

With a foot and second as units of length and time, we may take the value of g at the equator as 32, increasing gradually to about one-289th part more, or about ⅓ per cent. greater at the poles, in consequence of the Earth's rotation.

The force of a pound, meaning thereby the force with which the Earth appears to attract a pound weight, is thence about ⅓ per cent. greater at the poles than at the equator; and this does not allow for the increase in g due to the ellipticity, which by Clairaut's theorem would make the total increase about ½ per cent.

But to say that a body has gained in weight one-289th part, or ⅓ per cent., in going from the equator to the pole is absurd and misleading; for if we carry our standard weights and scales with us, we shall find that the body weighs exactly the same.

When the theorist tells us that a body gains or loses one-289th part of its weight in being taken from the equator to the pole, or back again, he means that the indications on a spring balance, graduated in latitude 45° by attaching standard weights, will be about ⅙ per cent. in error at the equator and at the poles.

But such a spring balance would be illegal if used according to its graduations in any other latitude than the one in which it was constructed; and the user would lose in all cases; he would lose at the equator by selling ⅙ per cent. too much by weight; and he would lose at the poles the fines incurred from the Inspector of Weights and Measures, who would test his spring balance by attaching standard weights, composed of lumps of metal.

The spring balance graduated in latitude 45°, and employed alternately at the equator and the pole, is equivalent to a beam balance, of which the beam stretches over a quadrant of the meridian of the Earth from the equator to the pole, with a fulcrum in latitude 45°, but such an abnormal balance is not contemplated in the Act.

4. If we could transport ourselves to the surface of the Moon, Sun, or any planet, with our weights and scales, Newton's Law of Universal Gravitation teaches us that we should still find the body of exactly the same weight in the balance, the attraction of the Moon, Sun, or planets on the body and on the weights being still equal.

The magnitudes of these equal attractions would, however, have changed, since the attraction is proportional to the local value of g; on the surface of the Moon it is calculated that g is about 5·4; on the surface of the Sun it is about 30 times the value on the surface of the earth, while on Jupiter it is calculated that g is about 71.

These values of g are inferred from observation of the diameter of the celestial body, and from its weight, measured in terms of the weight of the Earth, or using the Earth as the standard weight; and calculated by Kepler's Third Law from the period and distance of a satellite, compared with the period and distance of our satellite, the Moon.

The weight of the Earth itself is inferred from the Cavendish Experiment, in which the attraction of gravitation between two given weights is measured.

According to Newton's Law of Universal Gravitation, the attraction between two spherical bodies, arranged in spherical strata, the Sun and Earth for instance, weighing S and E g (grammes) when their centres are a cm apart, will be proportional to SEa^{-2}; with C.G.S. units, this attraction may be expressed as CSEa^{-2} dynes, and then C is called the *constant of gravitation;* and the Cavendish experiment is devised for the purpose of measuring C.

Denoting by g the acceleration of gravity (in C.G.S.

spouds), then on the surface of the Earth we may take, in round numbers,

$$g = \mathrm{CE}/\mathrm{R}^2, \text{ or } \mathrm{CE} = g\mathrm{R}^2,$$

R denoting the radius of the Earth in cm, taken as $10^9 \div \frac{1}{2}\pi$, the quadrant being 10^9 cm.

With mean density ρ, the weight of the Earth, E, in g, is given by

$$\mathrm{E} = \tfrac{4}{3}\pi\rho\mathrm{R}^3,$$

so that

$$\tfrac{4}{3}\pi\mathrm{RC}\rho = g,$$

or

$$\mathrm{C}\rho = \tfrac{3}{8}g \times 10^{-9};$$

so that ρ is known from C, and *vice versâ*.

For instance, with $\rho = 5{\cdot}5$, and $g = 981$,

$$\mathrm{C} = 10^{-8} \times 6{\cdot}688.$$

We are awaiting with great interest the quantitative results of Mr. C. V. Boys, with his improved form of apparatus; but meanwhile we may take a mean density of 5·5, the mean of Cornu's and Poynting's results, which is about half the density of lead. It is very extraordinary that this should agree so exactly with Newton's conjecture, *Principia*, lib. iii., prop. x. :—"Unde cum terra communis suprema quasi duplo gravior sit quam aqua, et paulo inferius in fodinis quasi triplo vel quadruplo aut etiam quintuplo gravior reperiatur: verisimile est quod copia materiæ totius in Terra quasi quintuplo vel sextuplo major sit quam si tota ex aqua constaret; præsertim cum Terram quasi quintuplo densiorem esse quam Jovem jam ante ostensum sit."

5. A short numerical calculation will now give us the *weight* of the Earth (Hamilton, "Lectures on Quaternions"); also of the Moon, Sun, &c.

We assume that the Earth is a sphere, whose girth is 40,000 kilometres, so that R, the radius of the Earth, is $10^7 \div \frac{1}{2}\pi$ m (metres), and the volume, V, is $\frac{4}{3}\pi\mathrm{R}^3$ m³, while the weight, E, is ρV t (metric tonnes of 1000 kg, or 2205 lbs.), where $\rho = 5{\cdot}5$.

Four-figure logarithms will suffice for our calculations; and now

$$\begin{aligned}
\log 10^7 &= 7{\cdot}000 \\
\log \tfrac{1}{2}\pi &= {\cdot}1961 \\
\log \mathrm{R} &= 6{\cdot}8039, \quad \mathrm{R} = 10^6 \times 6{\cdot}366 \text{ m}, \\
\log \mathrm{R}^3 &= 20{\cdot}4117 \\
\log \tfrac{4}{3}\pi &= {\cdot}6221 \\
\log \mathrm{V} &= 21{\cdot}0338, \quad \mathrm{V} = 10^{21} \times 1{\cdot}081 \text{ m}^3, \\
\log \rho &= {\cdot}7404 \\
\log \mathrm{E} &= 21{\cdot}7742, \quad \mathrm{E} = 10^{21} \times 5{\cdot}946 \text{ t},
\end{aligned}$$

or 6×10^{21} metric tonnes in round numbers.

The weight of the Moon, M, generally taken as one-80th of the Earth, will be $10^{19} \times 7{\cdot}432$ t.

To determine S, the weight of the Sun, we employ Kepler's Third Law, which gives

$$\frac{\mathrm{S} + \mathrm{E} + \mathrm{M}}{\mathrm{E} + \mathrm{M}} = \frac{n^2a^3}{n'^2a'^3},$$

where n, n' denote the mean motions of the Sun and Moon, and a, a' their mean distances from the Earth.

Since M is insignificant compared with E, and E compared with S, we may write this

$$\frac{\mathrm{S}}{\mathrm{E}} = \frac{n^2a^3}{n'^2a'^3},$$

where $n'/n = 13$, the number of lunations in a year, and $a/a' = 390$, the ratio of the mean distances of the Sun and the Moon, this being the ratio of 57′ to 8″·8, the inverse ratio of the parallaxes.

Now

$$\begin{aligned}
\log a/a' &= 2{\cdot}5911 \\
\log (a/a')^3 &= 7{\cdot}7733 \\
\log (n'/n)^2 &= 2{\cdot}2279 \\
\log \mathrm{S/E} &= 5{\cdot}5454, \quad \mathrm{S/E} = 351{,}100;
\end{aligned}$$

so that the weight of the Sun is about 350,000 times the weight of the Earth, or about 2×10^{27} t, or 2×10^{33}g.

To determine the value of G the acceleration of gravity on the surface of the Sun, compared with g, the value on the surface of the Earth, we have

$$\frac{\mathrm{G}}{g} = \frac{\mathrm{S}}{\mathrm{E}}\left(\frac{\text{diameter of earth}}{\text{diameter of sun}}\right)^2 = \frac{\mathrm{S}}{\mathrm{E}}\left(\frac{8{\cdot}8}{960}\right)^2,$$

since the apparent semi-diameter of the Sun as seen from the Earth is about 960″, while the apparent semi-diameter of the Earth as seen from the Sun, in other words the solar parallax, is taken as 8″·8.

Now

$$\begin{aligned}
\log 960 &= 2{\cdot}9823 \\
\log 8{\cdot}8 &= {\cdot}9445 \\
\log (960 \div 8{\cdot}8) &= 2{\cdot}0378 \\
\log (960 \div 8{\cdot}8)^2 &= 4{\cdot}0756 \\
\log \mathrm{S/E} &= 5{\cdot}5454 \\
\log \mathrm{G}/g &= 1{\cdot}4698, \quad \mathrm{G}/g = 29{\cdot}49.
\end{aligned}$$

6. According to Newton's Law of Universal Gravitation, the operation of weighing out the quantity W in the balance gives the same result wherever the operation is carried out in the universe, assuming that the balance and the body to be weighed are of ordinary moderate dimensions.

It is otherwise with the quantity denoted by P, because the magnitude of the gravitation unit of force varies, being proportional to the local value of g.

Suppose we write the first two equations

$$\mathrm{P}gs = \tfrac{1}{2}\mathrm{W}v^2, \quad \mathrm{P}gt = \mathrm{W}v,$$

and now put $\mathrm{P}g = \mathrm{Q}$; this is equivalent to taking a new unit of force, $1/g$th part of the former unit; this is an invariable unit.

Now our dynamical equations become

$$\mathrm{Q}s = \tfrac{1}{2}\mathrm{W}v^2, \quad \mathrm{Q}t = \mathrm{W}v,$$

from which g has disappeared.

The first suggestion of the change to this new absolute unit of force is due to Gauss, who found the necessity of it when comparing records of the Earth's magnetic force, made at different parts of the Earth's surface, and all expressed in the local gravitation unit.

It is curious that this suggestion of an absolute unit of force, the same for all the universe, did not originate with the astronomers; but Astronomy remains mere Kinematics until an accurate determination of the Gravitation Constant has been made.

On the F.P.S. (British foot-pound-second) system, this absolute unit of force is called the *poundal*, a name due to Prof. James Thomson; so that

$$\mathrm{Q}s = \tfrac{1}{2}\mathrm{W}v^2 \text{ (foot-poundals)}, \quad \mathrm{Q}t = \mathrm{W}v \text{ (second-poundals)}.$$

On the C.G.S. (Metric centimetre-gramme-second) system, this absolute unit of force is called the *dyne*, the centimetre-dyne of work being called the *erg*, and the second-dyne of impulse being called the *bole*; and now

$$\mathrm{Q}s = \tfrac{1}{2}\mathrm{W}v^2 \text{ (ergs)}, \quad \mathrm{Q}t = \mathrm{W}v \text{ (boles)}.$$

These absolute units are always employed in the statement of dynamical results in Electricity and Astronomy, where cosmopolitan interests are considered.

7. The disappearance of g from the dynamical equations is such a comfort to the algebraist, that he now makes a new start *ab initio* in dynamics, and gives a new definition of the absolute unit of force.

He defines the *poundal* as the force which, acting on a pound weight, makes the velocity grow one foot per second every second; and he defines the *dyne* as the force which, acting on a gramme weight, makes the velocity grow one centimetre per second every second; and now if W lbs. or g is acted upon by a force of Q poundals or dynes, the acceleration a is given by

$$a = \mathrm{Q/W} \text{ (\textit{celoes} or \textit{spouds})},$$

and

$$\mathrm{Q} = \mathrm{W}a,$$

leading to the original equations

$$\begin{aligned}
\mathrm{Q}s &= \tfrac{1}{2}\mathrm{W}v^2 \text{ (foot-poundals or ergs)}, \\
\mathrm{Q}t &= \mathrm{W}v \text{ (second-poundals or boles)}.
\end{aligned}$$

These definitions of the absolute unit of force are very elegant and useful so long as we confine ourselves to calculations on paper, but they will not satisfy legal requirements. There is no apparatus in existence which will measure a *poundal* or *dyne* from these academic definitions within, say, 10 per cent. For accurate definition we must return to the old gravitation measure, and define the *poundal* or *dyne* as one-gth part of the force with which the Earth attracts a pound weight or a gramme weight, the value of g (in celoes or spouds) being determined by pendulum observations; and now the standard weight and the value of g are capable of measurement to within, say, one-100th per cent., an accuracy sufficient to prevent litigation.

In the recent report of the Committee on Electrical Standards we find the *ohm* defined as the equivalent of a velocity of ten million metres (one quadrant of the Earth) per second, to satisfy theoretical requirements; but as this definition would be useless for commercial purposes, Dr. Hopkinson insisted that it was essential that an alternate definition should be given, legalizing certain bars of metal as standard ohms.

In converting absolute and gravitation measure, we must notice that there are, strictly speaking, three different g's in existence: (1) the g of pure gravity of a body falling freely; (2) the g determined by a plumb-line, or by a Foucault pendulum of which the plane of oscillation is free to rotate; (3) the g determined by a pendulum oscillating in a fixed vertical plane, about a fixed axis; this is the legal g, so to speak, although practically undistinguishable from the g given in (2).

Sir W. Thomson's Standard Electrical Balance Instruments are graduated in gravitation measure, so that, if calibrated at Glasgow, they are one-25th per cent. in error in London, and about one-7th per cent. in error at the equator, and a corresponding correction must be made.

An absolute Spring Balance instrument would possess a spurious absoluteness, in consequence of the deterioration of temper of the spring, and of its variation of strength with the temperature, as experienced in the Indicator.

8. There is no advantage or gain of simplicity by the use of absolute units in dynamical questions concerning motion which is due to the gravitational field of force; the only change being the removal of g from the denominator on the right hand side of our dynamical equations to the numerator on the left-hand side.

For this reason engineers and practical men invariably employ the gravitation unit of force in the dynamical questions which concern them; measuring, for instance, their forces in pounds, pressures in pounds per square foot or square inch, while at the same time measuring the quantity of matter in the moving parts by pound weights.

The absolute unit of force has only recently made its way into dynamical treatment, principally in consequence of the development of Electricity. Previously the gravitation unit was universally employed, with the consequence that W in the equations of motion always appeared qualified by a denominator g, in the form W/g.

9. Noticing that W never appeared alone, but always as $\frac{W}{g}$ (for instance, that if a celoes is the acceleration which a force of P pounds causes in a weight of W lbs., then

$$P = \frac{W}{g}a, \text{ or } a = \frac{P}{\frac{W}{g}}),$$

early writers on Dynamics were unfortunately tempted to make an abbreviation in writing and printing, by replacing $\frac{W}{g}$ by a single letter M; so that the dynamical equations could be printed

$$P = Ma \text{ (pounds)},$$
$$Ps = \tfrac{1}{2}Mv^2 \text{ (foot-pounds)},$$
$$Pt = Mv \text{ (second-pounds)},$$

each occupying one line of print.

This quantity M was variously called the *mass* of the body—a quantity *sui generis*—the *massiveness* of the body, the *inertia*, or the *invariable quantity of matter* in the body.

But if M denotes the invariable quantity of matter, we have this awkwardness, that M, the invariable quantity, is measured in terms of a variable unit, g pounds; while the force P, which varies with g, is always measured by means of a definite lump of metal, the pound weight.

This awkwardness is rectified if we change the unit of force, and measure P in absolute units, poundals, and M in lbs., but now M becomes the same as W, formerly; and its introduction only causes confusion, because M is still taken by most writers on Dynamics as defined by

$$M = \frac{W}{g};$$

thus making $W = Mg$, the source of all the confusion in our dynamical equations.

If weight W is measured in pounds, as the Act of Parliament directs, and if the unit of mass is one pound, so that M is also measured in pounds, then, if W and M refer to the same body, $W = M$, and not Mg.

If $W = Mg$, and W is measured in lbs., then M is measured in units of g lbs., a variable unit, unsuitable for a cosmopolitan question.

But if $W = Mg$, and M is measured in pounds, then weight W is measured in units of one-gth part of a pound, or *poundals*, which is illegal according to the Act on Weights and Measures, c. 19, 41 and 42 Victoria: "Any person who sells by any denomination of weight or measure other than one of the imperial weights or measures, or some multiple or part thereof, shall be liable to a fine not exceeding forty shillings for each such sale."

10. The theoretical writer overrides these difficulties by giving a new definition of Weight, not contemplated or mentioned in the Act of Parliament:

"The weight of a body is the force with which it is attracted by the Earth."

Let us examine this definition closely.

In the first place, it does not appear to contemplate the use of the word *weight*, except in reference to bodies on or near the surface of the Earth.

According to this definition, what is the weight of the Moon, or of a body on the Moon? Must the Moon be brought up to the surface of the Earth in fragments, or must the weight be estimated at the present distance of the Moon?

What, again, is the weight of the Sun, or of a body on the Sun? and what is the weight of the Earth itself?

And what does Sir Robert Ball mean when he writes that "the weight of Algol is about double the weight of the Sun"?

Considering, however, merely bodies of moderate size on the surface of the Earth, the attraction of pure gravity of the Earth is only to be found in a body falling freely; the tension of a thread by which a body is supported is influenced by the rotation of the Earth.

Again, the local value of g is, theoretically speaking, influenced by the position of the Moon and Sun; it is true that the influence is insensible on the plumb-line, although manifest on such a gigantic scale in its tide-producing effects.

Suppose, then, we employ the gravitation unit of force in the theorist's definition of the weight of a body. The definition now becomes an inexact truism asserting that the Earth attracts W lbs. with a force of W pounds, and inexact, because it neglects the discount in g due to the rotation of the Earth; and to say that "the weight of a body is the force with which it is attracted by the Earth" conveys no additional information.

Having introduced the word *mass*, primarily as a mere abbreviation in printing, and having subsequently changed the unit of mass so as to make the mass the same as the weight, the theorist is now trying to dislodge the word *weight* from its primary meaning, which it has possessed for thousands of years, as meaning the quantity of matter in a body, and is trying to degrade it into a subsidiary position, to express a mere secondary idea, the attraction of gravity; and that only on the surface of the earth, and even then not clearly defined.

We might as well define the pound sterling by its purchasing power in any locality, instead of by its proper definition as a certain quantity of gold.

11. So long as the gravitation unit of force alone was employed, the same number, which expressed the number of the weights which equilibrate the body, also expressed the number of pounds of force with which the Earth appeared to attract the body; and it is only in this sense that the weight of a body is "the force with which it is attracted by the Earth"; it is essential that the unit of force should be the gravitation unit, when this definition is employed.

We say, for instance, in Hydrostatics, that a ship is buoyed up by the water with a force equal to the weight of the displaced water, which is also equal to the weight of the ship, when in equilibrium.

Again, the head of water which will produce a pressure of 150 lbs. on the sq. inch, is always

$$150 \times 144 \div 62{\cdot}5 = 345{\cdot}6 \text{ feet},$$

whatever the local value of g; the numerical measure is always the same, although the amount may differ in consequence of the variation of g and the unit of force. A boiler tested to 150 lbs. on the square inch is tried one-25th per cent. more severely in Glasgow than in London. This variation, at most $\frac{1}{2}$ per cent., is not likely to lead to litigation—*De minimis non curat lex.*

There is no particular harm in the use of the word *mass*, provided it is always measured in the standard units of weight; there is this drawback, that there is no verb to "mass"; we can say that the body weighs W lbs., but we cannot say it "masses" M lbs.

Again, the Acts of Parliament do not regulate "Masses and Measures," but "Weights and Measures," "Poids et Mesures," "Maasse und Gewichte," "De Ponderibus et Mensuris."

The French language possesses the two words *Poids* and *Pesanteur*, both of which we translate by Weight.

Poids may be translated *mass*, or quantity of matter, *copia materiæ*; but that does not justify the degradation of *weight* down to the meaning of *pesanteur*, and that merely the *pesanteur* on the surface of the Earth; having already invented *mass*, the theorist must invent a new word to translate *pesanteur*; the word *heft* has been suggested, but the word *weight* must be left alone, to do double duty occasionally.

A libellous story of the Hudson Bay Company says that in their former dealings with the Red Indians, the weight of the factor's fist was always one pound; a good illustration of weight as meaning both *poids* and *pesanteur* to ignorant minds.

An amusing instance of the confusion of using *weight* in the double sense of *poids* and *pesanteur*, when not restricted to the provincial gravitation unit of the surface of the Earth, on which the human race is imprisoned, occurred in a lecture last year on Popular Astronomy. To illustrate the fact that g on the surface of the Sun is about 30 times greater than it is here (§ 5), the lecturer said, "An ordinary middle-aged man of this audience, if transported to the surface of the Sun, would *weigh about two tons*; but his reflections on this difficulty would be cut short by the immediate prospect of being converted into *two tons of fuel*."

12. Maxwell unfortunately lent his powerful aid to the attempt to degrade the word *weight* to mean merely *pesanteur*.

In a review of Whewell's "Writings and Correspondence," edited by Todhunter, Maxwell writes that—

"Finding the word weight employed in ordinary language to denote the quantity of matter in a body, though in scientific language it denotes the tendency of that body to move downwards, and at the same time supposing that the word mass in its scientific sense was not sufficiently established to be used without danger in ordinary language, Dr. Whewell endeavoured to make the word weight carry the meaning of the word mass. Thus he tells us that—the weight of the whole compound must be equal to the weight of the separate elements."

"It is evident that what Dr. Whewell should have said was—the mass of the whole compound must be equal to the sum of the masses of the separate elements."

But Whewell was quite right, because, at the time he wrote, mass was merely the printer's abbreviation for

$$\frac{W}{g}.$$

"We are reminded by Mr. Todhunter that the method of comparing quantities by weighing them is not strictly correct." (Compare this statement of Todhunter with that of Dr. Harkness in his article on "The Art of Weighing and Measuring," NATURE, August 15, 1889, p. 381, where it is pointed out that weighings can be carried out to within one 10-millionth part.)

Again, in Maxwell's "Theory of Heat" (p. 85), we read "In a rude age, before the invention of means for overcoming friction, the weight of bodies formed the chief obstacle to setting them in motion. It was only after some progress had been made in the art of throwing missiles, and in the use of wheel-carriages and floating vessels, that men's minds became practically impressed with the idea of mass as distinguished from weight. Accordingly, while almost all the metaphysicians who discussed the qualities of matter, assigned a prominent place to *weight* among the primary qualities, few or none of them perceived that the sole unalterable property of matter is its *mass*."

The question in dispute resolves itself, then, merely into a difference of terminology; and the metaphysicians are using the language universally employed up to the middle of this century, and are justified on all sides in their usuage: Maxwell might as well have criticized the traditional names which astronomers employ for the heavenly bodies.

Maxwell would even have edited the authorized and revised version of the New Testament; in *ὡσεὶ λίτρας ἑκατόν*—translated "about an hundred pound *weight*"—(John xix. 39), he proposed the omission of *weight*, probably inserted in the version to make a distinction from pounds *sterling*.

This addition of the word weight is common elsewhere, thus, "His Majesty's Warrant, August 19, 1683, to cause 3 barrels of fine pistol powder, 3 cwt. weight of pistol bullets, and 3 cwt. weight of match to be delivered to John Leake, Master Gunner, for the use of the 3 troops of Granadiers, &c." ("Notes on the Early History of the Royal Regiment of Artillery," by Colonel Cleaveland).

Dr. Lodge says that the term hundredweight bears marks of confusion on its surface, and had better be avoided; what does he say to this use of hundredweight weights, not intended to mean pull of gravity?

This Warrant is dated four years before the first edition of the "Principia," in which the downward tendency of a weight was first clearly demonstrated as due to the attraction of the Earth, although mere surmises had been propounded by early astronomers, and in "Troilus and Cressida" we have—"As the very centre of the earth, drawing all things to it."

But Acts of Parliament on "Weights and Measures" were extant hundreds of years before the first appearance of the "Principia"; and when the standard pound weight was defined in these Acts, it was the lump of metal preserved at the Exchequer that was described, and not the pressure on the bottom of the box in which it was kept.

13. Formerly, the words *vis inertiæ*, or *inertia*, were used instead of the modern word *mass* (often used in ordinary language as the equivalent of *bulk*). But it is useful to notice that inertia is not always the same thing as weight or mass, or even proportional to them.

Thus the inertia of a body is increased by the presence of the surrounding medium; the inertia of a sphere moving in a frictionless incompressible liquid is increased by half the weight of the liquid displaced, and of a cylinder moving perpendicular to the axis by the weight displaced; while an elongated projectile requires rotation about an axis for stability of flight, in consequence of its inertia being different for different directions of motion.

The inertia of a pendulum, or of the train in § 2, is increased to an appreciable extent by the presence of the surrounding air.

Again, the inertia of a rolling hoop is twice its weight, of a cylinder is half again as great, of a billiard ball is 40 per cent. greater; and the inertia of a bicycle, or of the train we have considered in § 2, when the *rotary inertia* of the wheels is taken into account, must be increased by a fraction of the weight of the wheels and axles equal to k^2/a^2, where a is the radius of a pair of wheels, and k the radius of gyration of the wheels and axle about the axis of rotation.

For the same reason the centre of inertia does not always coincide with the centre of gravity, or centre of mass. The buffers of a railway carriage should be at the height of the centre of inertia; and this is easily seen to be at a height

$$h\Big/\left(1+\frac{w}{W}\frac{k^2}{a^2}\right)$$

above the axles, w denoting the weight of the wheels, W of the body of the carriage, and h the height of its centre of gravity above the axles.

The recommendations of the A.I.G.T., in their "Syllabus of Elementary Dynamics," will only serve to widen the increasing gulf between theoretical treatises and the Applied Mechanics which engineers use, unless the Committee of the A.I.G.T. will set to work to invent a totally new word, such as *heft*, to express the pull of gravity on a given weight, as an equivalent of the French word *pesanteur;* it is hopeless to attempt todegrade the, old word *weight* into the subsidiary secondary meaning so long as in commerce, and in the Acts of Parliament, *weight* invariably means quantity of matter, *copia materiæ*.

A. G. Greenhill.

APHANAPTERYX AND OTHER REMAINS IN THE CHATHAM ISLANDS.

In a former letter I sent you some account of the finding of the *Aphanapteryx* in the Chatham Islands. I have now gone more carefully over the bones I collected there, and some additional notes may not be without interest. I find that, of the heads I have obtained, a number are much larger than that of *Aphanapteryx broeckei* (Schlegel), and are therefore rightly assigned, I think, to a distinct species. The tarso-metatarsus, as figured by M. Milne-Edwards, however, may, I think, prove to belong not to *Aphanapteryx*, or at any rate not to a species with so robust a tibia. I found several tarso-metatarsi in near relation to the tibiæ and femora, and heads of *A. hawkinsi*, and they are all without exception much shorter and stouter bones in proportion to the tibiæ and femora. Out of the same strata which contained *Aphanapteryx*, I obtained a number of the bones of the skeleton of a *Fulica* very nearly related to *F. newtoni*. Like the *Aphanapteryx* bones, they vary very much in size, some being equal, others much larger than those of *F. newtoni*. So much so that I am inclined to recognize them as different species, or at least different races. The larger species I have named *F. chathamensis*. The portions I have had before me are the pelvis, the femur, the tibia, and metatarsus. I have portions of a large ralline skull, which may be that of this *Fulica*, but it is rather too imperfect to enable me to speak more confidently at present. The tarso-metatarsi of this bird agree much more closely with the tarso-metatarsus assigned in M. Milne-Edwards's plate to *Aphanapteryx*. Of the *Aphanapteryx* I possess the complete cranium, femur, tibia, metatarsus, humerus, and pelvis. Among the other interesting specimens so far identified, are the humeri and pelvis of a species of Crow half as large again as *C. cornix*. They agree closely with those of a true *Corvus*. I have designated it as *Corvus moriorum*, as I found some of these bones among the remains scattered round a very ancient Moriori cooking-place, which had become uncovered by the wind in the strata in which *Aphanapteryx* occurs. Indeed, in this kitchen-midden I gathered portions of the *Aphanapteryx*, of a large swan, of several species of ducks, and of a *Carpophaga* indistinguishable from the species now living on the islands—a species (*Carpophaga chathamica* mihi[1]) new to science. I may say that it is easily distinguished from *C. novæ-zealandiæ* by the breast-shield in both sexes being altogether duller than, and not extending so far ventrally as, in the latter. The head, neck, and breast are of the same colour—a dull green, with purple and green metallic reflections when viewed with the bird between the light and the eye. It is, however, most markedly distinguished by the pale lavender colour of the external border of the wings, the much paler colour of the lower back and rump, and by the black on the under surface of the tail feathers being prominent on all the rectrices except on the anterior portions of the outer tail feather on each side, and passing under the tail coverts in a broad wedge. Mr. Travers relates that he was informed by one of the early settlers on Pitt Island that he remembered the first appearance of the pigeon in the islands. This statement cannot well be accepted in face of the presence of the bird's bones in a midden so ancient as that I have referred to above. In the *Aphanapteryx* beds, I obtained also the portions of a skull of a species of *Columbidæ*, apparently of a *Columba*, of which I can say little till I am in possession of more material. I have obtained also bones of the small hawk (*Harpa*), showing that it existed on the islands, whereas it is now unknown there, although *Circus gouldi* is not uncommon.

At about 3 feet below the floor of a small cave, which the weathering limestone has deposited, I obtained portions of a pigmy Weka (*Ocydromus pygmæus*), and also the limb bones of a rat. If they have been gradually covered to this depth by the fall of particles from the roof, as there seems no reason to doubt, their age must be very great; but whether that would take us back to a date antecedent to the arrival of the Morioris in the Chatham Islands is a more difficult question to answer with our present data.

So far, the birds of whose presence in the Chatham Islands till now we have had no knowlege, are: *Harpa ? ferox*, *Nestor meridionalis* and *? N. notabilis*, *Corvus*

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[1] ? *Carpophaga chathamensis* of Rothschild, P.Z.S. 1891, p. 312, pl. xxviii. —Ed.]

moriorum, *Ocydromus pygmæus*, *Fulica newtoni*, *F. chathamensis*, *Aphanapteryx hawkinsi*, *Ap.*? spp., *Chenopis sumnerensis*, *Carpophaga chathamica*, *Columba* sp.

HENRY O. FORBES.

Canterbury Museum, April 2.

ADMIRAL MOUCHEZ.

WE have already referred to the loss which French science has recently sustained in the sudden death of the director of the Paris Observatory, at the age of 71. It falls to the lot of few sailors in any country to take so large a share in scientific progress as did Admiral Mouchez, or to combine great administrative capacity with thorough knowledge and power of initiation.

His love for astronomy and geodesy first made itself felt when he was at the Collège Louis le Grand. Appointed to the navy in 1843, he was captain of a frigate in 1861, but three years before this he had communicated to the Academy of Sciences observations of the partial eclipse of the sun seen by him at Buenos Ayres on September 7, 1858. He was then in that locality constructing the hydrographical map of the eastern coast of South America. A year or two later he presented to the Academy a map of Paraguay, and he was presented as a candidate for filling the seat vacated by the untimely death of Bravais in 1863. But he was outvoted, and he continued his hydrographical work. He published a description of the coast of Brazil, and he observed an annular eclipse of the sun (on October 30, 1864) at San Catharina, Brazil.

When in 1872 expeditions were being organized by all countries to observe the transit of Venus in 1874, Mouchez was placed in command of the party which was destined for the island of Saint Paul. The climatic conditions of this island—either the winds are very violent, or the heaven is nearly always overcast—did not seem to favour the observers. The head of the expedition had the greatest difficulty in reaching his post, and it was in the middle of a violent storm that he had to approach the large volcano which was to be his station.

The evening of the day before the transit the rain fell in torrents; but the next day, at the moment wished for, by quite a fortunate chance, the storm cleared in consequence of a change of wind, and the veil of mist which covered the sky suddenly vanished; the observation was thus made under most favourable conditions. Mouchez was able to recognize the atmosphere of Venus very distinct from that of the Sun at the moment of contact.

The astronomical expedition which he commanded was composed of naturalists as well as astronomers; it has furnished science with interesting accounts of the geology, zoology, and botany of the islands of St. Paul and Amsterdam its neighbour.

On Mouchez's return to France he was promoted Commander of the Legion of Honour at the same time that he was nominated a member of the Academy of Sciences in the place of the astronomer Mathieu. In October 1875, at the annual public séance of the five academies, he gave an account of his expedition to the island St. Paul.

In 1878 he obtained from the French Admiralty the funds required for establishing at Montsouris, with the same instruments used by him at St. Paul, a school of astronomy for the use of marine officers and masters. This school is in full prosperity, and every year about a dozen men are trained in conducting astronomical and magnetical observations.

When Le Verrier died, on September 13, 1877, Mouchez, then commander, was appointed to the directorship of the National Observatory, and nearly simultaneously with this Commander Mouchez received the rank of Rear Admiral. He was put on the Reserve List in 1880.

Admiral Mouchez showed himself, at the Observatory, an active administrator. He brought about many marked improvements in the different branches of the establishment. He suggested the establishment of a practical school of astronomy, which has been worked for eight years consecutively, and has furnished all the French observatories with a remarkable supply of young astronomers. Thirty have passed through the two years' course.

Admiral Mouchez always encouraged useful researches, and the magnificent work undertaken with so much success by the brothers Henry in celestial photography, and the development of the *equatorial coudé*, under the fostering care of M. Loewy, must be specially mentioned here.

But by far the most important result of this kind which we owe to the Admiral's clear foresight and power of dealing with men is to be found in the Chart of the Heavens, which will remain as one of the memorable works of the science of the nineteenth century. It was on the proposal of the director of the observatory that the Academy of Sciences convoked foreign astronomers to take part in the Congress which, on three different occasions, assembled with so much success at the Paris Observatory.

This vast undertaking would have been impossible without the genius of the French nation and without such a man as Mouchez. It is essentially an international work which England should have started, but alas! in such matters our science is scarcely national; it is parochial, and so it must remain until the relations between science and the Government are changed.

Admiral Mouchez was a very zealous promoter of colonial observatories. He travelled to Algiers in order to preside over the inauguration of the large establishment erected by M. Trépied. This very year, having travelled to Tunis to recruit his failing health, he had taken steps for creating an astronomical station in the town of Zaghouan, and he was advocating the building of observatories at Tahiti and Tananarivo at the time of his death.

There are few astronomers who will not feel the death of Admiral Mouchez as the loss of a dear friend, and one in whom loyalty, honesty, and simplicity of character were so blended that the great services rendered by the savant were almost forgotten in the esteem felt for the man.

NOTES.

M. HECKEL, the President of the Botanical Section of the French Association for the Advancement of Science, proposes, as special subjects for discussion at the approaching meeting of the Association, to be held at Pau, the flora of the Alps and of the Pyrenees, and a comparison between them; and the best means of arranging and preserving botanical collections.

PROF. T. H. HUXLEY has been elected President, and Sir Henry Roscoe and the Master of University College, Oxford, two of the Vice-Presidents, of the Association for Promoting a Teaching University for London. Motions on the whole favourable to the plans of the Association have been carried by the Senate of the University of London and the Council of University College.

PROF. RAMSAY, in his report as Dean of the Faculty of Science in University College, London, has to record many changes during the past session. Reference is, of course, made to the retirement of Prof. Croom Robertson from the Chair of Philosophy, and to the appointment of Dr. James Sully as his successor. Prof. Ramsay's predecessor as Dean, Prof. Lankester, expressed to him his regret that he had not taken steps to ascertain the number of original investigations carried out during the time of his Deanship; and it occurred to Prof. Ramsay that no more fitting task could devolve on the Dean than to chronicle how far the progress of science is due to those, students and teachers, who work in University College. His colleagues have responded to his inquiries, and he has thus been able to lay before the Council a list of publications amounting in all to 84 separate memoirs or books. They contain accounts of researches in which professors, assistants, students, former students who are still at work in the College have taken part; and Prof. Ramsay maintains that in this, as well as in the routine of teaching, the College fulfils the duties of a true University. The record, he contends, equals, if it does not surpass, that of any University in the kingdom.

SINCE Saturday last Mount Etna has been in a state of eruption, and many severe shocks of earthquake have been felt in the surrounding country. From midnight till six o'clock on Saturday evening there were eleven distinct shocks. About noon on Saturday a great fissure opened on the summit of the mountain, from which lava began to issue with great rapidity. During the following night the eruption assumed alarming proportions, and huge quantities of lava streamed down the sides of the mountain. This rapidly flowed in two streams—one going in the direction of Nicolosi and the other towards Belpasso. There was a severe earthquake shock in the immediate vicinity of the volcano on Saturday night. On Sunday the people of Nicolosi assembled for mass outside the cathedral, and remained kneeling in the open air, being afraid to enter owing to the continued shocks of earthquake. At five o'clock in the evening the shocks continued, and very loud subterranean rumblings were heard, giving the impression of a terrible storm. Twelve houses and a portion of a church were destroyed. The eruption continued very active. On Monday it was stated that the rumblings had grown less frequent, and there were indications that the eruptions from the newly-formed fissure were about to cease. The principal crater, however, showed signs of renewed activity. On Tuesday the following telegram was despatched from Catania through Reuter's agency:—"The eruption of Mount Etna is again rapidly increasing in volume and intensity. Five craters at different points on the mountain are showing great activity. Loud explosions occur continually, and this morning there was a strong shock of earthquake. Giarre, on the coast to the north of Catania, has been reduced to ruins, and the whole country round has suffered severely. A number of engineers who have been sent to the points immediately threatened express fears that the wells will blow up on contact with the lava. There is no panic, and in the circumstances the people maintain a fairly calm demeanour."

A TERRIBLE disaster has happened in the neighbourhood of the sulphur springs of St. Gervais, a little way off the road from Geneva to Chamonix. According to a Reuter's telegram, despatched from Bonneville, Haute Savoie, on July 12, the calamity was due to the fact that the lower end of the glacier of Bionnay became detached from Mont Blanc and fell into the torrent beneath. It carried away with it the little village of the same name. The masses of ice and the wreck of the village formed a dam which held up the waters for some time, until they suddenly broke through the obstruction and burst like a cataract into the mountain stream, known as the Bon Nant, which flows by St. Gervais les Bains. These thermal springs, the medicinal virtues of which attract many visitors to the hotel during the year, rise in the wooded ravine of Montjoie, through which the Bon Nant or "Good Stream" passes on its way down to meet the river Arve. The gorge in which the Etablissement des Bains, erected at an altitude of 2066 feet above the level of the sea, stands, or rather stood, is narrow, and the hotel consisted of five separate buildings joined together by walls of stone roughly hewn from the mountain side. At a quarter past two on Tuesday morning or thereabouts, the people in the hotel were awakened by a terrific noise of rushing water, and the crashing of rocks one against the other. Then a furious gust of wind drove through the gorge. The next moment a torrent of water, carrying with it fragments of rock, trees, and débris of all descriptions, hurled itself upon the hotel. Of the five buildings, three were utterly destroyed, another was nearly so, while the fifth remained almost unhurt, owing its safety to its position, which was high above the course of the Bon Nant. Passing down the valley, the torrent struck the village of Le Fayet, which was almost entirely demolished. The wreckage of the houses was swept down the stream for miles into the river Arve, on the surface of which corpses and débris of all kinds were seen floating all day on Tuesday. According to the latest calculations on Tuesday evening, there were no fewer than 200 victims, more than half of whom were staying at the bathing establishment of St. Gervais.

THE following are among the Civil List pensions granted during the year ended June 20:—to Mrs. Caroline Emma Carpenter, £100, in consideration of the services rendered by her late husband, Dr. Philip Herbert Carpenter, F.R.S., to science, and of the sad circumstances in which she was left by his death; to Mr. Thomas Woodhouse Levin, £50, in consideration of the services he has rendered to education and philosophy and mental science, of his blindness, and of his inadequate means of support; to Dr. George Gore, F.R.S., £150, in consideration of his services to chemical and physical science; to Mr. Henry Dunning Macleod, M.A., £100, in consideration of his labours as a writer upon economical subjects; to Mr. Henry Bradley, £150, in consideration of his labours in connection with the "New English Dictionary"; to Miss Letitia Marian Cole, £30, Miss Henrietta Lindsay Cole, £30, and Miss Rose Owen Cole, £30, in recognition of the services rendered by the late Sir Henry Cole to the cause of artistic and scientific education; and to Mrs. Jeanie Gwynne Bettany, £50, in consideration of the services rendered to the spread of scientific knowledge by the numerous writings of her husband, the late Mr. G. T. Bettany, M.A.

MR. THOMAS HANBURY has presented to the Botanical Institute at Genoa the very rich collection of vascular plants made by the late Prof. Willkomm, of Prague. It comprises as many as 14,472 species, the greater number being European or from the adjacent districts of Asia and Africa. It is especially rich in plants of the Spanish Peninsula, and includes most of Willkomm's original type-specimens.

THE Society of Natural History of St. Petersburg has despatched Dr. K. N. Denkenbach on a mission to explore the flora of the Black Sea.

THE death is announced of Prof. Giovanni Flechia, Vice-President of the Reale Accademia delle Scienze of Turin.

THE series of fifteen water-colour paintings of the volcanic district in New Zealand, which were lent by Miss Constance F. Gordon Cumming to the Indian and Colonial Exhibition, are now lent to "The Castle" at Nottingham, where they will be shown for some little time. They were in the Indian and Colonial Exhibition at the time of the great eruption of Mount Tarawera, which destroyed the beautiful Terraces.

THE weather during the past week has been changeable, with frequent rain, more particularly in the north and west; 1·7 inch was measured on the west coast of Ireland on the morning of the 12th instant. At the time of our last issue a deep depression lay over the north of Scotland, the barometer being below 29 inches, while a moderate westerly gale was blowing in the

Channel, with a high sea; and other depressions have subsequently travelled to the northward of our islands. The weather, however, remained fair, but cloudy, in the southern parts of the kingdom, and fog prevailed on the north-east coast on Monday. The distribution of barometrical pressure has, for the most part, been favourable to westerly winds, the high barometer being situated over the north of France. A change, however, set in on Monday, accompanied by strong easterly winds and a falling barometer, the highest readings having shifted northward, with their centre situated to the eastward of our islands. These conditions were followed by fresh disturbances, accompanied by rainy and unsettled weather. Temperature has been lower than of late, although but little below the average; the highest day readings have seldom reached 70°. The *Weekly Weather Report* issued on the 9th showed that, for that week, bright sunshine continued fairly prevalent over the eastern and southern districts, and that there was a considerable excess of rainfall in Ireland and the northern and western parts of Scotland.

THE United States Weather Bureau has just published Bulletin No. 1, containing some interesting notes on the climate and meteorology of Death Valley, California. This valley lies between lats. 35° 40′ and 36° 35′ N. and longs. 116° 15′ and 117° 5′ W., and owes its name to the fate of a party of immigrants, who, about 1850, perished from thirst. The principal feature of interest about the place is that, although situated about 200 miles from the sea, it is said to lie 100 feet or more below the sea level, as determined from barometrical observations. The observations now published were commenced by the Geological Survey and the Signal Service, and were continued by the Weather Bureau during five months from May to September, 1891, and we believe these are the only regular observations, with trustworthy instruments, that have been made there. The principal meteorological features are the excessive heat and dryness; the temperature rises occasionally to 122° in the shade, and rarely falls during the hot season below 70°. It is said that the thermometer has sometimes reached 130°, and once even 137°. The diurnal range of the barometer is characteristic of the form found in continental valleys, being of the purest single maximum type, and has the largest amplitude known. The rainfall was extremely light, and was always either a slight sprinkle or a thunderstorm. The total fall for the five months was only 1·4 inches. It showed a distinct diurnal frequency; nearly all the hours of rain being during the night. Sand storms were also observed on several occasions.

THE Deutsche Seewarte has just issued Part IV. of their meteorological observations made at distant stations. The observations are made three times daily, and monthly means are added in the form agreed upon for international meteorological publications. These observations are especially valuable both on account of the remoteness of the places and of the details which are given about the stations and the instruments used. This volume contains observations made (1) at six stations in Labrador for 1887; (2) at Walfisch Bay for 1889; (3) in the Cameroon estuary, from April 1889 to June 1890; (4) at Bismarckburg, Togoland, West Africa, from June 1889 to May 1890; (5) at Chemulpo, Korea, from July 1888 to December 1889; (6) at Mohammera, mouth of the Euphrates, from June to August 1885; and (7) at Bushire, from September 1885 to March 1886. In some cases the introductory text contains general remarks relating to the tides and prominent features of the climate.

IN February 1888, Dr. E. Etienne was sent to Banana by the Congo Free State to direct the sanitary service, and he made regular meteorological observations there, six times daily from December 1, 1889, to May 16, 1891, which have now been published by the State. The range of temperature during the year 1890 presented great regularity, the absolute maximum, 93°·6, occurred in March, and the minimum, 61°·9, in July; the lowest maximum was 73°·9 in July, and the highest minimum, 79°·2, in April. The greatest monthly variability (the difference of the monthly mean from one month to another) was 5°·0 between May and June. The winds are very uniform: a land breeze from south-east to south at sunrise, then calm till about 11h. a.m.; a sea-breeze from south-west till about 7h. p.m., and a second calm about 10h. p.m. The rainy season of 1889–90 numbered fifty days, with a mean daily fall of 0·49 inch. The most remarkable fall was 1·2 inch in 45 minutes. The rainy season of 1890–91 differed considerably from the former; the number of wet days was only 29, with a mean daily fall of 0·52 inch, the total amount being about five-eighths of that in the previous year. In addition to the above there is a very small amount of rain in the dry season.

THAT iron is always present in small quantities in chlorophyll has been asserted over and over again in botanical text-books. Dr. H. Molisch, who has recently investigated the subject of the presence of iron in plants, disputes this, and asserts that he has never found a trace of iron in the ash of chlorophyll. He states that iron occurs in plants in two forms—in that of ordinary iron-salts, and in the "masked" condition, in which it is so closely combined with organic substances that the ordinary reagents fail to detect it. In this form iron occurs both in the cell-wall and in the cell-contents, but it does not enter into living protoplasm.

IN one of the alcoves of the Museum of the Academy of Natural Sciences, Philadelphia, there are various fossil bones of extinct animals belonging to the Pleistocene period, and along with them a human bone. These "finds" were presented to the Academy in 1846 by Dr. Dickeson, who discovered them in a single deposit at the foot of the bluff in the vicinity of Natchez, Mississippi. Specimens—one from the human bone, the other from one of the bones of a Mylodon—have been submitted for analysis to Prof. F. W. Clarke, chemist of the U.S. Geological Survey; and the result is reported by Dr. Thomas Wilson, of the Smithsonian Institution, in the current number of the *American Naturalist*. The human bone is in a higher state of fossilization than the Mylodon. It has less lime and more silica. In their other chemical constituents they are without any great difference. Of lime the bone of the Mylodon has 30·48 per cent., while that of man has but 25·88 per cent. Of silica the Mylodon has 3·71 per cent., while man has 22·59 per cent. Dr. Wilson refers to the ordinary uncertainty of this test when applied to specimens from different localities and subjected to different conditions, but points out that in the present case no such differences exist. The bones were all encased in the same stratum of blue clay, and were subjected practically to the same conditions and surroundings.

MR. A. J. COOK, of the Agricultural College, Michigan, has been making experiments to determine how much honey is needed to enable bees to secrete one pound of wax, and he has found that the amount is eleven pounds of honey. This is less than the amount given by Huber, and more than that stated by Viallon and Hasty. An account of the experiments and of many other interesting facts relating to apiculture will be found in a report included in Bulletin 26 of the U.S. Department of Agriculture.

AN interesting memoir of John Hancock, with portrait, opens the latest instalment (vol. xi. Part 1) of the Natural History Transactions of Northumberland, Durham, and Newcastle-upon-Tyne. The writer, Dr. Embleton, gives an excellent account of Hancock's masterly power of mounting animals. He notes also Hancock's remarkably intimate knowledge of the characters and habits of birds. "He could describe and imitate their motions and sounds so vividly, by feature, voice, and posture, as to be most instructive and at the same time amusing, whilst he convinced his auditors of the naturalness of his pantomime."

A paper on the Tertiary Rhynchophora of North America, by Mr. Samuel H. Scudder, has been reprinted from the Proceedings of the Boston Society of Natural History (Vol. 25). The assortment of the mass of Tertiary insects from American western deposits, upon which Mr. Scudder has been engaged for many years, has brought to light an unexpectedly large number of Rhynchophora, about eight hundred and fifty specimens having passed through Mr. Scudder's hands; of these, however, fully a hundred have proved too imperfect for present use or until other specimens in better condition may show what they are. Seven hundred and fifty-three specimens have served as the basis of a Monograph now being printed. More than half (431) of these specimens come from the single locality of Florissant, Colo., and excepting a single specimen from Fossil, Wyo., and another from Scarboro', Ontario, the others are divided between three localities not widely removed: the crest of the Roan Mountains in western Colorado, the buttes on either side of the lower White River near the Colorado-Utah boundary, and the immediate vicinity of Green River City, Wyoming. One hundred and ninety-three species are determined, divided among ninety-five genera, thirty-six tribes or sub-families, and six families, by which it will be seen at once that the fauna is a very varied one. It is richer than that of Europe, where there have been described (or merely indicated) only one hundred and fifty species, of which nine come from the Pleistocene. The older Tertiary rocks of America, therefore, are found to have already yielded nearly twenty-eight per cent. more forms than the corresponding European rocks. Although it is evident to any student of fossil insects that even in Tertiary deposits we possess but a mere fragment of the vast host which must have been entombed in the rocks, Mr. Scudder contends that we have already discovered such a variety and abundance of forms as to make it clear that there has been but little important change in the insect fauna of the world since the beginning of the Tertiary epoch.

In a paper on artesian water in New South Wales, printed in the current number of the Journal and Proceedings of the Royal Society of that colony, Prof. Edgeworth David says that water rises to the surface in many parts of the east-central portions of Australia from mud or mound springs. These occur chiefly in strata of Cretaceous age. The most remarkable groups are perhaps those on the Lower Flinders, which have been described by Mr. E. Palmer in the Proceedings of the Royal Society of Queensland. The springs erupt thin mud and hot water intermittently, and thus gradually build up around their orifices mounds of mud of a rudely crateriform shape. At Mount Browne, on the Lower Flinders, several feet above the general level of the plain, is a mud spring mound covered with gigantic tea-trees (*Melaleuca leucodendron*), among the matted roots of which the hot water steams in clear shining crystal pools. At the top of the mound is a large basin of hot water, stated to be fathomless. The roots and branches of the tea-trees lying in this water become coated with a soft green vegetable substance, with air bubbles clinging to them. Innumerable small bubbles of carbon-dioxide are continually rising to the surface of the basin. The water is too hot for the hand to bear for any length of time, but when cooled it is good for use and always bright and clear, and free from any taste, while that in the adjoining cold springs is extremely disagreeable. The temperature of the water in two of these hot springs at Mount Browne is 120° F. No change has been observed in the hot springs as regards level or temperature since 1865, when a cattle station was settled there.

Among the curiosities in the mines and mining building at the Chicago Exhibition will be a solid gold brick, weighing 500 pounds, and worth 150,000 dollars. It will be exhibited by a mine owner at Helena, Mon.

Dr. C. F. MacDonald, who has been present at the seven executions by electricity in New York State, has submitted to the State authorities a report, in which he contends that experience has thoroughly justified the abolition of hanging. When the new method is used, death, he maintains, occurs before any sensation of pain or shock can be conveyed to the brain of the condemned. Dr. MacDonald's conclusions are endorsed by a hundred physicians who have acted as witnesses at different executions.

The raisin industry is being gradually developed in Victoria, and promises shortly to be sufficient to supply the requirements of the colony. So says Mr. J. Knight, who writes on the subject in the new Bulletin of the Victoria Department of Agriculture. Extensive planting, he says, is going on in various parts of the colony, from the extreme west at Mildura along to the east as far as Wangaratta, the largest plantation being in the well-known Goulburn Valley. In this locality not only has the manufacture of raisins received attention during the last six years, but the products of the currant vine also are now being placed on the market.

The second volume of the *Photographic Annual* has been issued. It includes a vast number of advertisements, but contains also some able articles, among which we may especially note Mr. Albert Taylor's general view of the progress of astronomical photography during 1891.

In 1891 wide-spread alarm was caused in America by the presence of several species of destructive locusts in different parts of the country, particularly in the Western States. A general summary of these incursions was given in Mr. C. V. Riley's annual report for 1891, and now a Bulletin has been issued by the U S. Department of Agriculture giving the detailed reports of the agents who carefully examined the invaded districts.

A catalogue of the marine shells of Australia and Tasmania, compiled by John Brazier, F.L.S., is being printed by order of the trustees of the Australian Museum, Sydney. The first part, dealing with Cephalopoda, has been issued. The task cannot be accomplished very quickly, as it entails the examination of many thousands of specimens, both dry and in spirits. The catalogue will include not only the species represented in the general Museum collection, but also those in the Hargreave's collection presented to the trustees by the late Mr. Thomas Walker, and those recently purchased from Mr. Brazier.

Mr. R. Etheridge, Jun., gives, in the latest instalment of the Transactions of the Royal Society of Victoria, an interesting account of a fine specimen of an unusually large species of the genus Belonostomus, obtained in 1889 by Mr. George Sweet, of Brunswick, Melbourne, in the Rolling Downs formation (Cretaceous) of Central Queensland. The fossil exhibits a long, slender fish, with deep, narrow ganoid scales and feeble fins, bent upon itself at about the middle point, and wanting the greater part of the head. Species that are apparently allied have been recorded from the Upper Cretaceous of Western Europe, India, and Brazil, and Mr. Etheridge notes that the present discovery is of great interest as extending still further the ascertained geographical range of the genus during Cretaceous times.

The very extensive alterations in botanical nomenclature proposed in Kuntze's "Revisio Generum" has prompted a proposal, emanating from the four eminent German botanists, Ascherson, Engler, Schumann, and Urban, with the assent of a number of their colleagues, for a revision of De Candolle's "Lois de Nomenclature Botanique." The essential points of the propositions are that the starting-point for the priority of genera, as well as of species, shall be the year 1753, the date of the publication of Linnæus's "Species Plantarum"; that "nomina nuda" and "semi-nuda," *i.e.* names without a diagnosis, or with only a very imperfect diagnosis, shall be rejected, as well as figures without a diagnosis; that no generic name shall be rejected because of its similarity to another generic name, even if it differ only in the last syllable, but that, if the difference be in spelling only, the later name must be rejected; that the names of certain large and universally known genera be retained, even though they would have to be rejected by the strict rules of priority. English botanists are invited to signify their assent or otherwise to these propositions.

At the meeting of the Linnean Society of New South Wales, on May 25, Mr. Pedley exhibited a very fine and perfect saw, about 5 feet long, of the saw-fish *Pristis zysron*, Bleeker. The fish, without the saw, was about 19 feet long, and was captured in a net at Evans River, N.S.W. The number of pairs of rostral teeth for this species is usually given as from 26–32; the specimen exhibited had only 25 pairs, all in place. At the same meeting, Mr. Hedley exhibited, on behalf of Mr. Rainbow, a spider of the family *Epëiridæ*. This rare and remarkable insect furnishes an addition to the fauna of Australia, and it is supposed that a new genus may be required for its reception.

Mr. W. A. Rogers, writing to *Science* from Colby University, Waterville, Me., confirms testimony given by Mr. Kunz as to the fact that the hardness of diamonds is not perceptibly reduced by cutting and polishing. In the earlier years of Mr. Rogers's experience in ruling upon glass he was accustomed to select a gem with a smoothly-glazed surface, and, the stone being split in a cleavage plane inclined at a rather sharp angle to the natural face selected, this split face was ground and polished. In this way he was able to obtain at several points short knife-edges, which gave superb results in ruling. It was soon found, however, that after ruling several thousand rather heavy lines the diamond was liable to lose its sharp cutting-edge, and this experience became so frequent that he was compelled to resort to the method now employed, that of grinding and polishing both faces to a knife-edge. He has one ruling diamond prepared in this way, which has been in constant use for four years, and its capacity for good work has not yet been reduced in the slightest degree. A diamond prepared by Mr. Max Levy, of Philadelphia, has given even better results, and so far it shows no evidence of wear.

The *Bulletin de la Société des Naturalistes de Moscou* (1891, Nos. 2 and 3) contains a very interesting paper, in French, by Prof. A. Pavloff and Mr. G. W. Lamplugh, on the Speeton clays and their equivalents. These clays, which have long occupied the attention of geologists, have acquired of late a new interest owing to close resemblance between their fauna and that of similar deposits in other countries, even as far distant as Russia. The work consists of three parts: the first part, devoted to the description of the Speeton clays and their Lincolnshire equivalents, has been written by Mr. Lamplugh, and will, no doubt, be published in English as well. The second part, by Prof. Pavloff, is devoted to the description of the Cephalopods found in these clays, the Speeton forms being compared with those of other countries, and especially those of Russia. A table giving the succession of the subdivisions of the Jurassic and Cretaceous deposits, with their leading fossils, in the two Russian localities where they are best represented (Moscow and the lower Volga), is given by the author, and it differs from a previous table by the introduction of a new series, named Petchorian, which, although it has the thickness of but a few inches, has nevertheless a very peculiar fauna, of a well-determined character. However, for the present it is not possible to classify it either under the Jurassic or the Cretaceous formation. The table is followed by a detailed description of twenty-five species of Belemnites, of which eight are new, the chief interest of this description being in the attempt to give in each case the genealogical relations of closely allied species, and in a special chapter devoted to the geological history of Belemnites generally and the descent of various species supposed to have originated from the *Belemnites tripartitus* of the middle Jurassic and Lias epoch. In a subsequent paper, which will contain the third part of the work—namely, a comparison of the Speeton clays with those of other localities—the author proposes to describe in the same way the Speeton Ammonites, which are even more interesting than the Belemnites; and he hopes to be able then to give a more positive answer as to where the separation must be taken between the Jurassic and the Cretaceous deposits of the Speeton clays and analogous deposits.

Mr. Matthias Dunn writes to us from Mevagissey, Cornwall, that the fishing-boat *Mispah* landed a large shark there lately which had got entangled in her mackerel nets. Its length was 11 feet 2 inches, and in its stomach were two considerable-sized congers. The creature proved to be Couch's Ponbeagle Shark, or *Lamna cornubica* of Cuvier.

The additions to the Zoological Society's Gardens during the past week include a Tiger (*Felis tigris* ♂ jr.) from Amoy, China, presented by Mr. Robert Bruce; two Mountain Ka-kas (*Nestor notabilis*) from New Zealand, presented by the Earl of Onslow, K.C.M.G.; a Chilian Sea Eagle (*Geranoaetus melanoleucus*) from Chili, presented by Mr. Edward Jewell; a Broad-fronted Crocodile (*Crocodilus frontatus*) from West Africa, presented by Mr. G. T. Carter; a Common Boa (*Boa constrictor*) from South America, presented by Mr. A. E. Oakes; a Macaque Monkey (*Macacus cynomolgus* ♀) from India; a Kinkajou (*Cercoleptes caudivolvulus*) from Demerara, deposited; a Hippopotamus (*Hippopotamus amphibius* ♂) bred in Antwerp; sixteen Common Boas (*Boa constrictor*) from South America, purchased; an Indian Muntjac (*Cervulus muntjac* ♂) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Lunar Photography.—Dr. L. Weinek, of the Prague Observatory, has been the recipient of several photographs of the moon from Prof. Holden for the purpose of making enlargements from them. The photographs were obtained with the large equatorial of the Observatory at Mount Hamilton, and an illustration of one of the enlargements is given in *L'Astronomie* for July. The photograph is of the large crater Petavius, 153 kilometres in length. With M. Weinek's apparatus the photograph was enlarged twenty times, giving a lunar image of nearly three metres in diameter. At first sight the photograph looks as if the enlargement had been carried a little too far, but when held at arm's length the effect is very fine. The most striking features noticeable are the narrow river-like lines, which are numerous and very alike in appearance. Whether these are really photographic or not of course we cannot say, as we have not seen the original negatives, but they seem to be rather too distinct and natural to be taken for any impression other than photographic. What these rivers, if we may use such a term, are composed of is at present a subject of mere conjecture, but the day is not far off when a very careful systematic study will have to be undertaken to settle some of the questions that have been recently raised in respect to our satellite's surface.

COMET SWIFT (1892 MARCH 6).—The ephemeris of this comet for the ensuing week, taken from the *Edinburgh Circular*, No. 28, is as follows :—

Berlin Midnight.

1892.	R.A.	Decl.	log Δ.	log r.	Br.
	h. m. s.	° ′			
July 14	0 58 26	+49 20·8			
15	59 6	49 31·4			
16	0 59 44	49 41·8	0·2459	0·2776	0·15
17	1 0 19	49 51·9			
18	0 52	50 1·8			
19	1 22	50 11·5			
20	1 49	50 21·0	0·2488	0·2884	0·14

Brightness at time of discovery taken as unity. The comet lies in the southern extremity of the constellation of Cassiopeia.

OPPOSITION OF MARS.—All observatories which have the necessary equipment are especially invited by the United States Naval Observatory to join with them in making observations of the coming opposition of Mars. Observations should commence on June 20 to September 23, this period being divided into three parts, the comparison stars for the first section being O.A.S. 20970, η Capricorni, 27 Capricorni, φ Caoricorni, Lacaille 8851, 41 Capricorni, D.M. – 20°, 6923, Lalande 42700. It may be mentioned that observations made in accordance with the special circular which the U.S. Observatory has issued will be reduced by them.

SUN-SPOTS.—*Himmel und Erde* for July contains two very good photographs of the sun at the time of the great spot in the month of February. They were photographed by Dr. Lohse, at the Astrophysical Observatory at Potsdam. One was taken on February 13 at 10h., and shows the large group near central transit with a smaller group on the limb ; while in the other, the large group is nearer the western limb. A small disc represents the relative size of the earth for comparison.

REMARKABLE PROMINENCES.—The sun's atmosphere this year has been subject to many violent disturbances, indicated to us by the presence of spots, prominences, &c. The spots, with special reference to the February group, have already received much attention, but not so with the prominences. From a set of forty observations of the latter made between March 1 and May 31, 1892, by M. Trouvelot, 23 of these, as he says, belonged to the most interesting type, *i.e.*, eruptive. On April 6, 1892, there appeared an arched like prominence on the sun's limb, extending through 12°, the length of its base being 144,932 and its height 92,664 kilometres ; to give an idea of the size of this arch, it may be stated that as many as 22 globes the size of our earth might have simultaneously passed under it. At 10h. 54m., on the 8th of the same month, a huge column of light, in shape rather like a candle flame, rose to a height of 115,830, extending, in a little over half-an-hour, to 169,884 kilometres. A prominence of far greater length, occupying 34° of the solar limb, but of much less height than those mentioned above, was visible on April 15. Its base covered 410,632 kilometres, thus exceeding ten times the circumference of our earth.

GEOGRAPHICAL NOTES.

AT the last meeting of the Council of the Royal Geographical Society for the present session, it was unanimously agreed to admit women as Fellows on the same terms as men. There is nothing in the society's charter to limit the membership to men, and the proposal of admitting ladies has been made several times, and on the last occasion—two years ago—was nearly carried. As there will not be another meeting of the society until the opening of next session, the election of the first lady F.R.G.S. cannot take place until November.

THE Annual Congress of the French Geographical Societies meets this year at Lille in the first week of August, for the consideration of questions relating mainly to France and its colonies. The French Association for the Advancement of Science will hold its meeting at Pau, as we have already announced, in the third week of September. Its Geographical Section will be presided over by M. E. Anthoine, head of the French Map Department and of Graphic Statistics under the Minister of the Interior. In all departments of geography there is a remarkable revival of interest among Frenchmen at the present time, although the narrow or national aspect of the subject predominates over the wider or cosmopolitan.

A CURIOUS account of the piratical Tugere tribe of New Guinea has been published in most of the continental geographical journals on the authority of "an English medical missionary, Dr. Montague," who was picked up by a Dutch war-vessel near the boundary of Dutch and British New Guinea. This gentleman told a remarkable narrative of his capture and imprisonment by the Tugere, but as no English missionary of his name is known to be in New Guinea, nor has any mission station been recently raided by the Tugere, there is no doubt that some mistake has been made. It is impossible that so serious an incident as the imprisonment of an English missionary could be unknown in this country, and unless strong evidence were forthcoming, it is difficult to believe that such a thoroughly piratical people as the Tugere could show the diligence in agriculture and the relatively high civilization with which the story credits them.

M. E. A. MARTEL continues his researches into the subterranean geography of France. In March last he descended the "unfathomable" Creux-Percé on the plateau of Langres, proving it to be only 180 feet deep. It is a hollow in Jurassic limestone, and, although open to daylight, forms a natural ice-house, having a temperature of 28°F. when the external air was at 58°. In June he examined the still more remarkable Creux de Souci in the department of the Puy de Dôme. It proved to be a rounded cavity in recent basalt, 115 feet deep, having the appearance of being formed by a great gas bubble. A stagnant pool occupied the bottom of the pit, and above it the air was so much impregnated with carbonic acid that a candle would not burn. In this instance also the temperature fell as the distance from the surface increased, that of the external air being 51°, of the air at the bottom of the shaft 34°, and the water itself 34°·3. The Paris Society of Commercial Geography recently awarded a medal to M. Martel on account of the practical value of his researches in leading to the regulation of the underground drainage of Greece.

EASTER ISLAND.

THE prehistoric remains of Easter Island make it for archæologists one of the most interesting islands in the Pacific. They will therefore read with interest an elaborate paper in the Report of the U.S. National Museum for 1888–89, which has just been issued. The paper is entitled "Te Pito Te Henua, or Easter Island," and is by William J. Thomson, Paymaster, U.S. Navy. It records the results of researches made by Mr. Thomson during a visit paid to Easter Island by the American vessel, the *Mohican*, towards the end of 1886. The *Mohican* anchored in the Bay of Hanga Roa on the morning of December 18, 1886, and remained till the evening of the last day of the year, when she sailed for Valparaiso. Mr. Thomson and some of his comrades, interested in the relics of a past phase of life in the island, made the most of the short time at their disposal, and his essay will certainly rank among the most important contributions which have been made to our knowledge of the subject with which it deals.

He begins with a general account of Easter Island, and in this part of his work has succeeded in presenting compactly and clearly much valuable information. Of the geological features of the island he says that they are "replete with interest." The formation is purely volcanic, and embraces every variety pertaining to that structure. The tufaceous lavas form the most prominent element in the physiognomy of the island. To them, with the action of the trade-winds and heavy rains, is due the fact that Easter Island is surrounded by precipitous cliffs, rising in some cases to a thousand feet in height. The formation is extremely friable, and by the action of the elements enormous masses are continually disappearing beneath the waves that beat on the unprotected shore. Both on the coast-line and in the interior there are many natural caves. Some of these are of undoubted antiquity, and bear evidence of having been used by early inhabitants as dwellings and burial-places. It is reported that small images, inscribed tablets, and other objects of interest have been hidden away in such caves and lost through land-slides.

The climate is not unlike that of Madeira, with one wet and one dry season. Yams, potatoes, and taro are cultivated, the young plants being protected from the fierce heat of the sun by a mulching of dried grass gathered from the uncultivated ground. Bananas are grown, and so is sugar-cane, but the natives do not extract the juice for the purpose of making sugar. A wild gourd is common, and constituted the only water-jar and domestic utensil known to the islanders. Mr. Thomson saw no flowering plants indigenous to the soil, but ferns of many varieties are common, and grow in profusion in the craters of the volcanoes. Except in a few exposed places, the slopes of the hills and the valleys are covered with a perennial grass resembling the Jamaica grass (*Paspalum*). This natural growth supplies ample pasturage for cattle and sheep.

The only quadrupeds peculiar to the island are several varieties of rodents. Fish abounds in the surrounding sea, and has always been the principal means of support for the islanders. Turtles are also plentiful, and are highly esteemed. The turtle occupies a prominent place in tradition, and is frequently represented in the hieroglyphics. It appears also on sculptured rocks.

According to the traditions of the natives, the island was discovered by King Hotu-Matua, who came from the land in the direction of the rising sun, with two large double canoes and three hundred chosen followers. Mr. Thomson thinks there may have been more than one migration of people to the island, and that their traditions may have been mingled together; but there can, he believes, be no reasonable doubt about the progenitors of the present islanders being of the Malayo-Polynesian stock. The people were shockingly treated by some of the early voyagers, and in 1863 the majority of the able-bodied men were kidnapped by Peruvians, who carried them away to work in the guano deposits of the Chincha Islands and the plantations in Peru. Just before the arrival of the *Mohican* a complete census of the population had been taken by Mr. Salmon, who found that the total number of natives was 155. The children are not much darker than Europeans, but the skin assumes a brown hue as they grow up and are exposed to the sun and trade-winds. The eyes are dark brown, bright, and full, with black brows and lashes not very heavy. The countenance is usually open, modest, and pleasing. In disposition the natives are cheerful and contented. They all profess Christianity, but there are now no missionaries among them, and they display a tendency to return to the old Pagan ideas. Tattooing is no longer practised, but every islander advanced in life is ornamented in all parts of the body.

At one time the island must have been densely populated, and the surviving monuments show that the inhabitants had attained to a higher civilization than that of other Polynesians. The ancient stone houses at Orongo were thoroughly explored by Mr. Thomson and his party. These curious dwellings seem to have been built for the accommodation of the natives while the festival of the "sea-birds' eggs" was being celebrated. During the winter months the island is visited by great numbers of sea-birds, most of which build their nests among the ledges and cliffs of the inaccessible rocks. Some, however, choose two islets lying a few hundred yards from the south-west point of Easter Island, and the natives are believed to have selected Orongo as a convenient spot for watching for the coming of the birds. The fortunate person who obtained possession of the first egg, and returned with it unbroken to the expectant crowd, became entitled to certain privileges and rights during the following year. Near Orongo are the most important sculptured rocks in the island. They are covered with carvings intended to represent human faces, birds, fishes, and mythical animals, all very much defaced by the time and the elements. The most common figure is a mythical animal, half human in form, with bowed back and long claw-like legs and arms. According to the natives, this symbol represented "Meke-Meke," the great Spirit of the sea.

On the high bluff west of Kotatake Mountain the party discovered the ruins of a settlement extending more than a mile along the coast-line and inland to the base of the hill. These remains bear unmistakable evidences of being the oldest habitations on the island. The houses are elliptical in shape, with doorways facing the sea, and were built of uncut stone. Some of the walls are standing, but the majority are scattered about in confusion. Each dwelling was provided with a small cave or niche at the rear end, built of loose lava stones, which was in a number of instances covered by an arch supported by a fairly shaped key-stone. The recesses were "undoubtedly designed to contain the household gods."

Mr. Thomson has, of course, much to say about the stone images with the idea of which Easter Island is intimately associated in the minds of all who have devoted any attention to its antiquities. Every image in the island was counted, and the list shows a total of 555 images. Mr. Thomson says:—

"Of this number forty are standing inside of the crater, and nearly as many more on the outside of Rana Roraka, at the foot of the slope where they were placed as finished and ready for removal to the different platforms for which they were designed; some finished statues lie scattered over the plains as though they were being dragged toward a particular locality but were suddenly abandoned. The large majority of the images, however, are lying near platforms all around the coast, all more or less mutilated, and some reduced to a mere shapeless fragment. Not one stands in its original position upon a platform. The largest image is in one of the workshops in an unfinished state, and measures 70 feet in length; the smallest was found in one of the caves, and is a little short of three feet in length. One of the largest images that has been in position lies near the platform which it ornamented, near Ovahe; it is 32 feet long, and weighs 50 tons.

"Images representing females were found. One at Anakena is called 'Viri-viri Moai-a-Taka,' and is apparently as perfect as the day it was finished; another, on the plain west of Rana Roraka is called 'Moai Putu,' and is in a fair state of preservation. The natives have names for every one of the images. The designation of images and platforms as obtained from the guides during the exploration was afterwards checked off in company with other individuals without confusion in the record. The course gray trachytic lava of which the images were made is found only in the vicinity of Rana Roraka, and was selected because the conglomerate character of the material made it easily worked with the rude stone implements that constituted the only tools possessed by the natives. The disintegration of the material when exposed to the action of the elements is about equivalent to that of sandstone under similar conditions, and admits of an estimate in regard to the probable age. The traditions in regard to the images are numerous, but relate principally to impossible occurrences, such as being endowed with power to walk about in the darkness, assisting certain clans by subtle means in contests, and delivering oracular judgments. The legends state that a son of King Mahuta Ariiki, named Tro Kaiho, designed the first image, but it is difficult to arrive at an estimation of the period. The journals of the early navigators throw but little light upon the subject. The workshops must have been in operation at the time of Captain Cook's visit, but unfortunately his exploration of the island was not directed towards the crater of Rana Roraka.

"Although the images range in size from the colossus of 70 feet down to the pigmy of 3 feet, they are clearly all of the same type and general characteristics. The head is long, the eyes close under the heavy brows, the nose long, low-bridged, and expanded at the nostrils, the upper lip short and the lips pouting. The aspect is slightly upwards, and the expression is firm and profoundly solemn. Careful investigation failed to detect the slightest evidence that the sockets had ever been fitted with artificial eyes, made of bone and obsidian, such as are placed in the wooden images.

"The head was in all cases cut flat on top, to accommodate the red tufa crowns with which they were ornamented, but the images standing outside of the crater had flatter heads and bodies than those found around the coast. The images represent the human body only from the head to the hips, where it is cut squarely off to afford a good polygon of support when standing. The artists seem to have exhausted their talents in executing the features, very little work being done below the shoulders, and the arms being merely cut in low relief. The ears are only rectangular projections, but the lobes are represented longer in the older statues than in those of more recent date.

"The images were designed as effigies of distinguished persons, and intended as monuments to perpetuate their memory. They were never regarded as idols, and were not venerated or worshipped in any manner. The natives had their tutelary genii, gods, and goddesses, but they were represented by small wooden or stone idols, which bore no relation to the images that ornamented the burial platforms. The image-makers were a privileged class, and the profession descended from father to son.

Some of the natives still claim a descent from the image-makers, and refer to their ancestors with as much pride as to the royal family.

"The work of carving the image into shape, and detaching it from the rock of which it was a part, did not consume a great deal of time, but the chief difficulty was, in the absence of mechanical contrivances, to launch it safely down the slope of the mountain and transport it to a distant point. It was lowered to the plain by a system of chocks and wedges, and the rest was a dead drag accomplished by main strength. A roadway was constructed, over which the images were dragged by means of ropes made of indigenous hemp, and sea-weed and grass made excellent lubricants. The platforms were all built with sloping terraces in the rear, and up this incline a temporary road-way was constructed of a suitable height, upon which the statue could be rolled until the base was over its proper resting-place. The earth was then dug away to allow the image to settle down into position, the ropes being used to steady it in the meantime."

Interesting as these monuments are, they are less remarkable than the incised tablets which show that the Easter Islanders had worked out for themselves a kind of writing. The following account of the tablets is given by Mr. Thomson. Their existence "was not known until the missionaries settled upon the island, Numerous specimens were found in the possession of the natives, but no especial attention appears to have been directed towards them. Several persons, belonging to vessels that were wrecked at Easter Island, report having seen such tablets, but the natives could not be induced to part with them. The three hundred islanders who emigrated to Tahiti had in their possession a number of tablets; they created some attention on account of the remarkable skill with which the figures were executed, but they were highly prized by the owners, and no effort was made to secure them because their real value was not discovered. The Chilian corvette *O'Higgins* visited Easter Island in January 1870, and Captain Gana secured three tablets, two of which are on deposit in the National Museum at Santiago de Chili, and the third was sent to France, but does not appear to have reached its destination. Paper impressions and casts were taken from the Chilian tablets for the various Museums of Europe. Those sent to the English Ethnological Society created some interest after a time, but others sent to Berlin were regarded as stamps for marking native cloth (*Mittheilungen*, July 1871). Seven of these tablets are now in the possession of Tepano Jansser, Bishop of Axieri, all in excellent state of preservation.

"While the *Mohican* was at Tahiti, the Bishop kindly permitted us to examine these tablets and take photographs of them. These tablets were obtained from the missionaries who had been stationed on Easter Island, and they ranged in size from 5½ inches in length by 4 inches broad, to 5½ feet in length and 7 inches wide. Diligent search was made for specimens of these tablets during our visit to Easter Island. At first the natives denied having any, but Mr. Salmon knew of the existence of two, and these were finally purchased after a great deal of trouble and at considerable expense. The tablets obtained are in a fair state of preservation. The large one is a piece of driftwood that from its peculiar shape is supposed to have been used as a portion of a canoe. The other is made of the toromiro wood indigenous to the island. In explanation of the disappearance of these tablets, the natives stated that the missionaries had ordered all that could be found to be burned, with a view to destroying the ancient records, and getting rid of everything that would have a tendency to attach them to their heathenism, and prevent their thorough conversion to Christianity. The loss to the science of philology by this destruction of valuable relics is too great to be estimated. The native traditions in regard to the incised tablets simply assert that Hotu-Matua, the first king, possessed the knowledge of this written language, and brought with him to the island sixty-seven tablets containing allegories, traditions, genealogical tables, and proverbs relating to the land from which he had migrated. A knowledge of the written characters was confined to the royal family, the chiefs of the six districts into which the island was divided, sons of those chiefs, and certain priests or teachers, but the people were assembled at Anekena Bay once each year to hear all of the tablets read. The feast of the tablets was regarded as their most important *fête* day, and not even war was allowed to interfere with it.

"The combination of circumstances that caused the sudden arrest of image-making, and resulted in the abandonment of all such work on the island, never to be again revived, may have had its effect upon the art of writing. The tablets that have been found in the best stage of preservation would correspond very nearly with the age of the unfinished images in the workshops. The ability to read the characters may have continued until 1864, when the Peruvian slavers captured a large number of the inhabitants, and among those kidnapped were all of the officials and persons in authority. After this outrage, the traditions, &c., embraced by the tablets, seem to have been repeated on particular occasions, but the value of the characters was not understood, and was lost to the natives.

"A casual glance at the Easter Island tablets is sufficient to note the fact that they differ materially from other kyriologic writings. The pictorial symbols are engraved in regular lines on depressed channels, separated by slight ridges intended to protect the hieroglyphics from injury by rubbing. In some cases the characters are smaller, and the tablets contain a greater number of lines, but in all cases the hieroglyphics are incised, and cover both sides as well as the bevelled edges and hollows of the board upon which they are engraved. The symbols on each line are alternately reversed; those on the first stand upright, and those on the next line are upside down, and so on by regular alternation.

"This unique plan makes it necessary for the reader to turn the tablet and change its position at the end of every line; by this means the characters will be found to follow in regular procession. The reading should commence at the lower left-hand corner, on the particular side that will bring the figures erect, and followed as the characters face in the procession, turning the tablet at the end of each line, as indicated. Arriving at the top of the first face, the reading is continued over the edge to the nearest line, at the top of the other side, and the descent continues in the same manner until the end is reached. The Boustrophedon method is supposed to have been adopted in order to avoid the possibility of missing a line of hieroglyphics."

A man called Ure Vaeiko, one of the patriarchs of the island, professed to have been under instructions in the art of hieroglyphic reading at the time of the Peruvian visit, and claimed to understand most of the characters. The photographs of the tablets owned by the Bishop were submitted to this old man, who related with fluency and without hesitation the legend which he declared to be appropriate to each. "The story of all the tablets of which we had knowledge," says Mr. Thomson, "was finally obtained, the words of the native being written down by Mr. Salmon as they were uttered, and afterwards translated into English."

Ure Vaeiko's tales, with the translations, are printed in Mr. Thomson's paper; and, as they are manifestly not the reciter's own invention, they have a certain interest for students of anthropology. But whether they represent the meaning of the inscriptions on the mysterious tablets is another question. It is noteworthy that, although Ure Vaeiko's fluent interpretation of the tablets was not interrupted, "it became evident that he was not actually reading the characters." "It was noticed that the shifting of the position did not accord with the number of the symbols on the lines, and afterwards, when the photograph of another tablet was substituted, the same story was continued without the change being discovered." These facts raise a doubt as to the trustworthiness of his pretensions to knowledge. However, Mr. Thomson does not seem to have yet presented a full account of the work accomplished in connection with this curious problem. "Results of an extremely interesting nature," he says, "are barely outlined at present, and not in shape to be presented herewith. It is not considered expedient to attempt an explanation of the symbols until the subject can be treated exhaustively."

It remains for us only to say that the paper is richly illustrated, and accompanied by a map of Easter Island.

EMBRYOGENY OF GNETUM.

THE remarkable observations of Treub on the mode of fertilization in the *Casuarinaceæ*,[1] have been followed by some almost equally interesting, by Herr Karsten, on the formation of the embryo in *Gnetum*. The following is a summary of the more important points, as described in the *Botanische Zeitung*.

The inner integument of the ovule develops into a long tube leading to the apex of the nucellus, and projecting far beyond the other two integuments; it forms, at its apex, a drop of sweet fluid which captures the pollen-grains carried by the wind or possibly by insects. The outermost very thick integument becomes fleshy and bright-coloured, and is attractive to herbivorous animals. In the division of the cells of the nucellus at an early stage there is no evident predestination of one, as there is in most Angiosperms, as the mother-cell of the embryo-sac. In *Gnetum Gnemon* and *neglectum* there are usually two, three, or even more embryo-sacs which appear equally capable of further development; while in *G. edule*, and allied forms, the author found only one. In the division of the contents of the embryo-sac no differentiation of a female apparatus takes place in any of the species examined; no corpuscles or special ovum-cells are formed, and no antipodals; but the protoplasm of the embryo-sac divides into a parietal layer of primordial cells, which appear to be altogether equivalent, and which represent so many ovum-cells capable of fertilization.

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[1] See NATURE, vol. xlv. p. 548.

As the pollen-tube lengthens, its nucleus gives off a smaller vegetative nucleus, probably soon after the entrance of the tube into the tissue of the nucellus. The two nuclei remain very near one another; the vegetative nucleus or prothallium cell remains unchanged, while the generative nucleus increases greatly in size and divides into two. In *G. edule* the apex of the pollen-tube has now entered the apex of the embryo-sac; while in *G. neglectum* it appears to make a curve to avoid the apex of the sac, and becomes closely applied to its lower portion. After the pollen-tube has entered the embryo-sac its vegetative nucleus disappears, while each of the two generative nuclei surrounds itself with a membrane of protoplasm, and the nucleus of each of these generative cells divides into four or eight. The actual coalescence of the male and female nuclei was not observed; but a number of small nuclei were detected in the male generative cells, in addition to its four (or eight) comparatively large male nuclei, which the author regards as the nuclei of the primordial ovum-cells which have wandered into the male generative cells; and the coalescence must take place within the male generative cell. After the entrance of the pollen-tube, the parietal layer of protoplasm of the embryo-sac, in which the female primordial cells are imbedded, breaks up into an endosperm tissue.

The author regards *Gnetum* as representing a higher type of the order *Gnetaceæ* than the other genera, *Welwitschia* and *Ephedra;* the fact that no endosperm is formed before fertilization indicating an advance on other Gymnosperms. The presence of a large number of embryo-sacs, and the absence in them of antipodals, may indicate some analogy with *Casuarina*. The processes described above finally negative, in the opinion of the author, the theory that the antipodals are a survival of the female prothallium of Vascular Cryptogams; they appear, rather, to be a degenerate and functionless female sexual apparatus. According to this view, there are, in the embryo-sac of Angiosperms, two female sexual apparatuses of similar origin, the vegetative nuclei of which coalesce in each; but one of the two apparatuses is altogether abortive. Both the antipodals and the egg-apparatus or embryonic vesicles consist of an archegone reduced to a single cell.

A. W. B.

INTERNATIONAL CONGRESS OF EXPERIMENTAL PSYCHOLOGY.

THE second session of the above Congress will be held in London on Monday, August 1, 1892, and the three following days, under the presidency of Prof. H. Sidgwick. The Congress will assemble in the rooms of University College, Gower Street (kindly lent for the purpose), from 10 to 1 and from 2 to 4.30. The following papers have been arranged for:—

Dr. ALEXANDER BAIN ...	"The Respective Spheres and the Mutual Aids of Introspection and Experiment in Psychology."
Prof. M. BALDWIN ...	"Suggestion and Will."
Prof. BEAUNIS	"Psychological Questioning" (Des questionnaires psychologiques).
Dr. BÉRILLON	"The Applications of Hypnotic Suggestion to Education."
Prof. BERNHEIM	"The Psychical Character of Hysterical Amblyopia."
M. BINET	"The Psychology of Insects."
Prof. DELBŒUF	"The Appreciation of Time by Somnambulists."
Dr. DONALDSON	"Laura Bridgman."
Dr. VAN EEDEN... ...	"Principles of Psycho-Therapeutics."
Prof. EBBINGHAUS ...	"Theory of Colour-perception."
Dr. GOLDSCHEIDER ...	"Investigations into the Muscular Sense of the Blind."
Prof. STANLEY-HALL ...	"Recent Researches in the Psychology of the Skin."
Prof. HENSCHEN... ...	"The Visual Centre in the Cortex of the Calcarine Fissure."
Prof. HEYMANS	"Inhibition of Presentations."
Prof. V. HORSLEY ...	"The Degree of Localization of Movements and Correlative Sensations."
Prof. PIERRE JANET ...	"Loss of Volitional Power (l'aboulie)."
Prof. N. LANGE	"A Law of Perception."
Prof. LIÉGEOIS	"The Female Poisoner of Aïn-Fezza."
Prof. LEHMANN	"Experimental Inquiry into the relation of Respiration to Attention."
Dr. LIGHTNER-WITMER	"The Direct and Associative Factors in Judgments of Æsthetic Proportion."
Prof. LOMBROSO	"The Sensibility of Women, Normal, Insane, and Criminal."
Dr. MENDELSSOHN ...	"Investigations into the Parallel Law of Fechner."
Prof. LLOYD MORGAN ...	"The Limits of Animal Intelligence."
Prof. G. E. MÜLLER ...	"The Experimental Investigation of Memory."
Prof. MÜNSTERBERG ...	"The Psycho-Physical Basis of the Feelings."
Mr. F. W. H. MYERS ...	"The Experimental Induction of Hallucinations."
Dr. W. R. NEWBOLD ...	"The Characteristics and Conditions of the Simplest Forms of Belief."
Prof. PREYER	"The Origin of Numbers."
Prof. RIBOT	"General Ideas."
Prof. RICHET	"The Future of Psychology."
Prof. SCHÄFER	"The Anatomical and Physiological Relations of the Frontal Lobes."
Mrs. SIDGWICK	"Experiments in Thought-Transference."
Dr. E. B. TITCHENER ...	"Binocular After-images."
Prof. TSCHISCH	"Relation of Reaction-time to the Breadth of Perception."
Dr. VERRIEST	"The Physiological Basis of Rhythmic Speech."
Dr. WALLER	"On the Functional Attributes of the Cerebral Cortex."

The Meetings of the Congress will be General and Sectional. It is provisionally arranged that the General Meetings will be held on Monday or Thursday, and on the afternoons of Tuesday and Wednesday; and that the Sectional Meetings will be held on Tuesday and Wednesday Mornings, and if necessary on Thursday Morning. There will be two Sections at least: Section A, Neurology and Psychophysics; and Section B, Hypnotism and Cognate Questions. Under Section A will fall, for example, the papers of M. Binet, Profs. Henschen, Horsley, Schäfer, Waller, &c.; under Section B will fall the papers of Dr. Bérillon, Profs. Bernheim, Delbœuf, Liégecis, Dr. Van Eeden, Mr. F. W. H. Myers, and Mrs. Sidgwick.

Reports will be given in by Profs. Sidgwick and James and M. Marillier of the results of the census of hallucinations which it was decided to carry out at the first Session of the Congress (Paris, 1889).

A Committee of Reception has been formed, which includes, among others, the following names:—Dr. A. Bain, Dr. D. Ferrier, Mr. F. Galton, Dr. Shadworth Hodgson, Prof. V. Horsley, Dr. Hughlings Jackson, Dr. Charles Mercier, Prof. Croom Robertson, Dr. G. J. Romanes, Mr. Herbert Spencer, Mr. G. F. Stout, Dr. J. Ward, and Dr. de Watteville.

The fee for attendance at the Congress is ten shillings, which will entitle to a printed report of the proceedings. Any intending members who have not yet paid the fee are requested to send it to Prof. Sully.

During the Congress letters may be addressed to Members at the Council Room, University College, Gower Street, London, W.C., where each Member is requested to inscribe his name, on his first attendance at the Congress.

F. W. H. MYERS,
Leckhampton House, Cambridge.
JAMES SULLY,
East Heath Road, Hampstead, London, N.W.

SCIENTIFIC SERIALS.

THE current number of the *Royal Agricultural Society's Journal* is, perhaps, of more than usual interest. The first article is on Vermin of the Farm, by J. E. Harting, and is followed by an editorial note on the same subject. The plague of "mice" on the hill pastures of Scotland this spring gives a special interest to these articles. It appears that the Scotch plague is caused not by mice, but by fieldvoles (*Arvicola agrestis*), and the destruction they have wrought in the hill pastures of Scotland arises from the fondness of these voles for the delicate white stems of the hillside herbage. Judging from the reports of similar plagues in previous years it would appear that the natural enemies of the vole—the short-eared owl and the kestrel hawk—are far more efficacious remedies than any artificial means yet devised for the destruction of the voles; hence a paper on Wild Birds in relation to Agriculture, by Earl Cathcart, is very opportune, protesting as it does against the careless destruction of such birds as the owl, the hawk, and the rook. The Journal also contains a second paper by Mr. Dan Pidgeon on the Evolution of Agricultural Implements. A suggestive paper by Mr. William E. Bear on Desirable Agricultural Experiments advocates extensive experiments to test the economy of nitrogenous manuring by means of leguminous crops. Other papers in this number are Contagious Footrot in Sheep, by Prof. G. T. Brown; Variations of the Four-course System, by Gilbert Murray; and the Trial of Ploughs at Warwick, by F. S. Courtenay.

SOCIETIES AND ACADEMIES.

Oxford University Junior Scientific Club, May 27.—The biennial conversazione of the Club was held in the University Museum, when an address inaugural to the recently founded "Robert Boyle lectures of the O.U.J.S.C." was delivered by Prof. Sir Henry W. Acland, Bart., K.C.B., F.R.S., on Robert Boyle, his life, work, and influence on science. A very interesting series of exhibits was shown by the various departments of the Museum and by the University Observatory, illustrating recent progress in their particular branches of science. Of special interest were the exhibits by the Rev. F. J. Smith on shadow and objective spark photography, illustrated by pictures of objects in rapid motion; by Mr. Cecil Carus-Wilson, of natural and artificial musical sands; by the University Observers, of a series of splendid photographs illustrating recent improvements in astronomical and spectral photography; by the National Telephone Company, of telephonic apparatus; by Dr. Hunt, of preparations and cultivations illustrating the methods of isolation and identification of bacteria; by Mr. B. V. Darbishire, of a series of lantern views in the Caucasus and in the British East Africa Company's territory, the slides for which were kindly lent by the Royal Geographical Society. The Club is much indebted to the Royal Society, the Pharmaceutical Society, the Right Hon. the Earl of Cork and Orrery, Prof. Wyndham R. Dunstan, Prof. Odling, and other gentlemen for the loan of oil paintings, engravings, and relics of Robert Boyle and his contemporary men of science in Oxford.

June 3.—The President, Mr. W. Ramsden, in the chair.—The following papers were read:—The sub-salts of the alkali metals, by Mr. W. Pullinger.—The action of silicon-tetrachloride on benzene, by Mr. C. H. H. Walker.—Marriages of consanguinity, by Mr. H. Anglin Whitelocke.—A new and improved form of rotatory hypsometer, by Mr. S. A. Sworn (Balliol). Mr. C. J. Romanes was elected an honorary member of the Club.

June 14.—The President, Mr. W. Ramsden, in the chair.—The following papers were read:—The action of iodine on a mixture of sulphites and thiosulphates, by Mr. H. A. Colefax.—On marine nests, by Mr. W. B. Benham.

EDINBURGH.

Royal Society, June 20.—Dr. Traquair exhibited some remains of animals occurring in volcanic tuff at Teneriffe.—Dr. Hunter Stewart read a paper on the variations in the amount of carbonic acid gas in the ground air.—Dr. Buchan discussed the diurnal variations of barometric readings in the polar regions during summer. From observations made in the summer of 1876 and the two succeeding summers, in the central part of the North Atlantic, between 62° and 80° north latitude, he showed that only one maximum and one minimum occur during the day. Observations made by the *Challenger* staff in high antarctic latitudes during summer give the same result. A single maximum and a single minimum are also found in the interior parts of the polar continents, but these occur at different times of the day from the ocean maximum and minimum. Superposition of the two sets of variations gives a variation like that ordinarily observed.

July 4.—The Hon. Lord Maclaren, Vice-President, in the chair.—Dr. A. W. Hughes read a paper on the rotatory movements of the human vertebral column. Among other results he points out that while the lumbar vertebræ cannot rotate much about a vertical axis, the dorsal vertebræ are capable of considerable rotation—the total rotation of this part of the vertebral column being 45° or more—and the cervical vertebræ are still more free—the total amount being at least 90°.—Mr. R. Kidston discussed the genus *Lepidophloios*, Sternb.—Prof. C. G. Knott and Mr. A. Shand communicated some further notes on the volume effects of magnetization. Five iron tubes, with bores varying from 16·0 to 3·5 mm. diameter, but otherwise identical in form and substance, were subjected to a series of magnetizing forces. In low fields the thinner-walled tubes experienced the greater dilatations of internal volume; but in high fields the narrower bored tubes showed much the greater dilatations. For example, in field 1400 the dilatations of the tubes in order, beginning with the one of widest bore and thinnest wall, were $+4$, -3, -20, -53, and -129—each being multiplied by 10^{-7}. With the two tubes of widest bore, the change of volume had reached its limit at this high field, the substance being practically saturated; but with the tubes of narrowest bore there was no evidence of a limit being reached, the innermost layers of iron being evidently far from practical saturation. Some interesting illustrations of magnetic after-effect were also described.—Dr. A. B. Griffiths submitted a paper on the blood of the invertebrata.—Prof. Tait communicated the second part of a paper on the laws of motion. If we assume the principles of inertia of matter and conservation of energy (the energy of a self-contained system consisting of the kinetic energy of all its parts supposed to be moving with the speed of its centre of inertia, the kinetic energy of relative motion of its parts, and the potential energy of its parts), the fact that we cannot attach any definite meaning to the principle of conservation, except when the motion of the system is Galilei-wise, leads at once to the first and third laws of motion, since the centre of inertia moves uniformly in a straight line; and the second law becomes merely a definition of the word "force" as used in the first law, and as used instead of "action" and "reaction" in one interpretation of the third.

PARIS.

Academy of Sciences, July 4.—M. d'Abbadie in the chair.—On local disturbances produced underneath a heavy load uniformly distributed along a straight line normal to the two edges, on the upper surface of a rectangular beam: experimental verifications, by M. J. Boussinesq.—Resemblances in the march of evolution on the old continent and the new, by M. Albert Gaudry.—Experimental researches on falling bodies and the resistance of air to their motion: experiments performed at the Eiffel Tower, by MM. L. Cailletet and E. Colardeau. Metallic spheres were let fall from the second platform of the Eiffel

Tower, and their exact time of describing certain distances was measured to a hundredth of a second by means of an electric chronograph. The body was fixed to a very light thread wound round a set of inverted cones, each of which held 20m. of thread. The latter passed from one cone to another through two fine springs in contact, which contact was broken by the string pulling through, thus producing a mark on the chronograph. The retardation produced by the string was independently determined and found to be less than 0·001 per cent. The following laws were verified: that the resistance of the air is proportional to the area of the resisting surface; and that it is independent of the form of the surface. That it is also proportional to the square of the velocity was not found to be strictly true, since the resistance increased rather more rapidly. The amount of fall after which the velocity of the weights employed became uniform ranged from 60m. to 100m. Contribution to the study of the function of camphoric acid, by M. A. Haller.—A new contribution to the history of morbid associations; anthrax and paludism, by M. Verneuil.—Fixation of ammoniacal nitrogen on straw, by M. de Vogüé.—On the nature of the rotation of the knife-edge of a pendulum on its plane of suspension, by M. G. Defforges. This rotation is not a simple rolling, as was assumed by Euler and Laplace, but is compounded with a sliding motion, whose existence can be proved by means of interference fringes. The sliding is proportional to the amplitude and up to six or seven kgr. to the weight.—On the influence of the place of the external thermometer in observations of zenith distances, by M. Périgaud. In calculating the error due to refraction by Arago's method, the density of the layer of air in the neighbourhood of the objective is measured by a thermometer placed outside the room, near the north side of the observatory. It was sought to fulfil the conditions of the problem more rigidly by suspending a thermometer quite close to the objective. The zenith-distances, calculated on the basis of its indications, showed a difference of 0·2 to 0·8 from those obtained by Arago's method, which made the zenith distances too large. The writer's method has been adopted at the great transit-instrument of the Paris Observatory. —On the primary forms of linear differential equations of the second order, by M. Ludwig Schlesinger.—On the precise determination of the critical density, by M. E. Mathias. This determination is aided by the law of the rectilineal diameter, according to which in the curve of temperatures and densities the locus of the midpoints of the chords parallel to the axis of the ordinates is a straight line. This law, recently confirmed by Young's experiments, implies that the critical density is equal to the ordinate of the diameter which corresponds to the critical temperature. Calculated according to this law, the critical densities of methyl, ethyl, and propyl alcohol are found to be the same.—Influence of the mass of the liquid in the phenomena of heating, by W. A. Witz.—Measurement of the dielectric constant by electromagnetic oscillations, by M. A. Pérot. By the method described, the constant K was determined for glass, and found to range from 2·71 if charged for $72·6 \times 10^{-10}$ sec. to 5·727 if charged for $453·7 \times 10^{-10}$ sec.—On the composition of water and Gay-Lussac's law of volumes, by M. A. Leduc. The writer's researches on the densities of gases have led him to adopt the value 23·24 for the percentage of oxygen in the air. The density of oxygen was determined by a modification of Dumas's process, in which the hydrogen was absorbed by finely-laminated electrolytic copper. The atomic weight deduced was 15·88, while the mean of the best values for the density is 15·90. This shows that Gay-Lussac's law of volumes is only approximate.—On the nitrogen salts of platinum, by M. M. Vèzes.—Researches on the sodic pyrogallols, by M. de Forcrand.—On acetono-resorcine, by M. H. Causse.—Utilization of roasted iron pyrites for the manufacture of iron salts, by MM. A. and P. Buisine.—On the alterations of ferruginous waters, by M. F. Parmentier.—Reproduction of pure potassic nepheline, by M. André Duboin.—On the passage of dissolved substances through mineral filters and capillary tubes, by M. C. Chabrie.—On hæmocyanine, by M. Léon Frédéricq. —On the physiological determinism in the metamorphosis of the silk-worm, by M. E. Bataillon.—On a new *Temnocephala*, a parasite of *Astacoides madagascariensis*, by M. A. Vayssière. —Earthworms and tuberculosis, by MM. Lortet and Despeignes. Proving that worms can bring the bacillus to the surface, preserving all its virulent properties.—On the Californian disease, a disease of the vine caused by *Plasmodiophora californica*, by MM. P. Viala and C. Sauvageau.—An essay on vegetable statics, by M. Augustin Letellier.—On the cavern called the Creux de Souci (Puy-de-Dome), by MM. E. Martel, A. Delebecque, and G. Gaupillat.—On the lakes of the central plateau of France, by MM. A. Delebecque and E. Ritter.

BERLIN.

Physical Society, June 3.—Prof. Schwalbe, President, in the chair.—Dr. Gross continued his remarks on the subject of entropy.—Dr. Wien gave an account of experiments on the measurement of high temperatures, made in conjunction with Dr. Holborn, with a view to testing Le Chatelier's platinum and rhodium thermo-elements. They were first compared with an air-thermometer. The latter consisted of a glazed porcelain tube containing slightly rarefied air, the temperature being recorded by a manometer. The thermo-element was introduced into the cavity of the air-thermometer, and the readings of the respective instruments were compared between −80° and +1500°. Below 500° the thermo-element was not very sensitive, and is hence of use only for high temperatures. Alloys of platinum with 9, 10, 11, 20 and 40 per cent. of rhodium were tried. It was found that the E.M.F. increased with the increased percentage of rhodium, but that the most suitable alloy was that containing 10 per cent. of rhodium as recommended by Le Chatelier. The above experiments necessitated the determination of the co-efficient of linear expansion of Berlin porcelain. This was found to be ·000004. In some final experiments the melting-point of gold was determined to be 1073° and 1067°, of silver 972° and 968°, and of copper 1082°.

June 17.—Prof. Kundt, President, in the chair.—Prof. Vogel exhibited a remarkably fine series of coloured prints of oil paintings, &c., prepared in accordance with his method by Messrs. Vogel and Ulrich. The method consists in first taking a red, a yellow, and a blue negative of the object on plates specially sensitized for colours. The three negatives are then printed on to one and the same paper by means of complementarily coloured rollers or stones. In order to obtain the colours exactly complementary to those of the negatives, the colours used for printing were either the coloured sensitizers themselves or some substance whose equivalence to these had been determined spectroscopically. The application of the physical principles involved in the above yielded an approximate reproduction of the natural colours which was surprisingly complete, and will become more so as more and more coloured substances are discovered suitable as sensitizers.—Prof. Koenig described his new spectrophotometer. Its chief improvement consists in the introduction of Lummer and Brodhun's glass-cube, which is, however, so modified as to admit of the measurement of the relative intensities of the parallel rays falling into it.

Physiological Society, June 24.—Prof. du Bois Raymond, President, in the chair.—Prof. Kossel communicated the results of some experiments made by Dr. Monti on the absorption of oxygen by the tissues after death, using for this purpose their reducing action on photographic plates. The suprarenals, spleen, and thymus reduced most actively, while brain-substances produced but little effect. Dr. Lilienfeld had investigated the distribution of phosphorus in various tissues by means of micro-chemical reactions with ammonium molybdate and pyrogallol. The presence of phosphorus was usually strongly marked in the nuclei as compared with the cell-substance, except in the case of the cerebral ganglia, in which the reverse was frequently observed. Prof. Gad drew attention to a phenomenon, brought to his notice by Prof. Litten, which may be observed during normal human respiration, and consists in the downward passage of an obvious wave over the wall of the thorax at each inspiration and the upward passage of a similar wave at each expiration.

AMSTERDAM.

Royal Academy of Sciences, June 25.—Prof. van der Waals in the chair.—Prof. T. Forster spoke (1) On the action of heat upon tuberculous matter. According to former investigations by "pasteurizing" (*i.e.*, warming liquids to a temperature of 60 to 80° C. for a short time and cooling them immediately), bacteria of Asiatic cholera and typhoid-fever are killed at about

60°. From a hygienic point of view it is of still more importance to discover what is the lowest temperature at which the bacilli of tuberculosis are destroyed. It is established that tuberculosis is produced by the consumption of milk secreted by tuberculous cows. Meat also, coming from tuberculous cattle, sometimes contains infectious matter. By boiling heat, indeed, the bacilli of tuberculosis are killed. But if meat is prepared in the usual manner, even small pieces of it are not warmed thoroughly at 100° C.; milk, on the other hand changes in taste if boiled, so that most people do not like boiled milk. By a series of experiments, recently made, Prof. Forster has settled that the bacilli of tuberculosis are destroyed by a temperature of 60° C. acting during one hour, and by the action during six hours of a temperature of 55° C. Higher temperatures than 60°, for instance, 80, 90 or 95° C., destroy the infectious matter in milk from tuberculous cows, if they act during *ten* minutes; "pasteurizing," however, at 80° during *one* minute does not hurt the bacilli of tuberculosis. (2) On the development of bacteria at a temperature of melting ice. He had formerly demonstrated cultivations of bacteria, which produce light of phosphorescence. The same kind of bacteria are also able to develop and to multiply at a temperature of 0° C. He found that bacteria which have this peculiar quality, so interesting from a biological point of view, not only live in the sea, but are met with in brackish and fresh water, upon victuals, manures, etc., etc. This agrees with the fact that victuals, kept for some days in an ice-chamber, gradually assume a disagreeable smell and taste; and that meat can be preserved from putrefaction for days but not for weeks. If foods are to be preserved at a low temperature for a long time, beside cold a second agent is necessary—dryness. In the cooling rooms of the most modern establishments (slaughterhouses, stores, etc., etc.) no use is made of ice, which after melting moistens the atmosphere and the objects in the ice-chambers, but arrangements are made by which the atmosphere is cooled to a low temperature and at the same time kept perfectly dry.—M. Beyerinck spoke of the culture of organisms of nitrification on agar-agar and on gelatine. First it was stated, in accordance with the discovery of Warington and Winogradsky, that nitrification consists in two processess—the formation of nitrous acid from the ammonsalt by a specific bacterium and the oxidation of the nitrite into nitrate by another and independent species of bacterium. Secondly, that both these processes occur only when soluble organic matter is reduced to a minimum such as has been proved by the classic researches of Winogradsky and the Franklands. Even 0·1 per cent. of calcium-acetate retards nitrification strongly. Thirdly, it was found that organic matter in the solid state does not in the least interrupt or retard nitrification. Therefore an attempt was made—and successfully—to cultivate the nitrous and nitric bacteria on agar-agar, fully extracted with distilled water and afterwards boiled with the inorganic salts needed for nitrification. If with these salts some pure precipitated carbonate of lime was added to the agar it was possible to obtain a "chalk-agar-plate," whereon the nitrous bacteria of the soil, after their growth into colonies, could directly be numbered. For this purpose the chalk-agar is poured into a glass-box, and some soil suspended in sterilised water brought on the surface of the solidified plate. After three to four weeks the colonies become visible as the centres of clear, transparent, perfectly circular diffusion figures, formed by the solution of the carbonate of lime in the nitrous acid, the very soluble calcium-nitrite diffusing in all directions in the agar-plate. In this way it was found, for example, that out of c.a. 10 millogrammes soil taken from under a sod of white clover in a garden at Delft, thirty colonies of the nitrous bacterium could be cultivated. The species is the same as that described as the European form by Winogradsky, growing, as well as zooglœa, quite free, and possessing the form of a small, moveable mikrokok with one cilium. Gelatine, prepared with the same precautions as the agar, can also be used, but therein the production of nitrous acid soon ceases. The nitrous bacterium does not liquefy the gelatine. Though it does not grow or oxidize when organic matter is present, it does not lose these powers by this contact, as shown when brought anew under adequate conditions. The nitric bacterium was also isolated on fully extracted agar, to which 0·1 per cent. potassium-nitrite and some phosphate was added. The colonies are very small and coloured light yellow. They consist of very small non-moving mikrokoks or short ellipsoids. They lose their power of oxidizing nitrites by the contact of soluble organic matter, without thereby losing their power of growth. The nitric bacterium does not oxidize ammonsalts. It is also without action on potassium rhodanate and hydrochloric-hydroxylamine. It therefore does not seem to produce free acid such as the nitrous bacterium. A simple method for the formation of sterile plates of silica, with and without carbonate, was also described. Many preparations were demonstrated.

BOOKS AND SERIALS RECEIVED.

BOOKS.—Grasses: C. H. Jones (S.P.C K.).—A Synoptical Geography of the World (Blackie).—London Matriculation Directory, No. xii., June 1892 (Clive).—The Case against Bimetallism: R. Giffen (Bell).—The Birds of Devon: W. S. M. D'Urban and Rev. M. A. Mathew (Porter).—Universal Atlas. Part 16 (Cassell).—Photography Annual, 1892 (Iliffe).—Muséum d'Histoire Naturelle des Pays Bas; tome xi., Cat. Systématique des Mammifères: F. A. Jentink (Leide, Brill).—The Applications of Elliptic Functions: A. G. Greenhill (Macmillan and Co.).—Sunshine: A. Johnson (Macmillan and Co.).—Theory of Numbers, Part 1: G. B. Mathews (Bell).—Alcohol and Public Health: Dr. J. J. Ridge (Lewis).—Murray's Hand-book; Norway, 8th edition (Murray).

SERIALS.—Transactions of the County of Middlesex Natural History and Scientific Society, Sessions 1889-90, 1890, and 1891 (London).—Natural Science, No. 5 (Macmillan and Co.).—L'Anthropologie, 1892, tome 3, No. 3 (Paris, Masson).—Bulletin de l'Académie Royale des Sciences de Belgique, No. 5 (Bruxelles).—Journal of the Royal Agricultural Society of England, 3rd series, vol. 3, Part 2, No. x. (Murray).—Department of Agriculture, Victoria, Bulletin No 14 (Melbourne).—The Asclepiad, No. 34, vol. ix. (Longmans).—Mind, July (Williams and Norgate).—Journal of Anatomy and Physiology, July (Williams and Norgate).—Archives des Sciences Biologiques publiées par l'Institut Impérial de Médecine Expérimentale à St. Pétersbourg, tome 1, No. 3 (St. Petersburg).—Geological Magazine, July (K. Paul).—Annals of Scottish Natural History, No. 3 (Edinburgh, Douglas).—Medical Magazine, vol. 1, No. 1 (Southwood).—Journal of the Royal Statistical Society, June (Stanford).—Journal of the Chemical Society, July (Gurney and Jackson).—Quarterly Journal of Microscopical Science, No. 132 (Churchill).

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THURSDAY, JULY 21, 1892.

DR. MIVART'S ESSAYS.

Essays and Criticisms. By St. George Mivart, F.R.S. (London: Osgood, M'Ilvaine, and Co., 1892.)

DR. MIVART has collected in two portly volumes a number of essays and critical reviews which he has from time to time contributed to current monthly or quarterly literature. The ground covered is tolerably extensive; from "Jacobinism" and "The French Revolution" to "Weismann's Theories" and "Eimer on Growth and Inheritance;" from "Austrian Monasteries" and "The Greyfriars" to "Herbert Spencer" and "Hermann Lotze." We have read the whole, or almost the whole, with interest, and not without admiration of the author's wide knowledge, his earnest purpose, and his power of clear exposition. Here, however, we are chiefly concerned with those essays which deal with scientific problems. They are well worthy of reperusal in their present collected form, and that chiefly because Dr. Mivart holds definite and in some respects peculiar views on evolution, because he has the advantage of some training in philosophy, because he is a learned and acute critic, and because he has pre-eminently the courage of his convictions.

It is scarcely necessary to remind the readers of NATURE that Dr. Mivart is one of those who hold that natural selection has played a quite subordinate part in the evolution of organisms. He believes that the concurrence of certain external exciting causes acts in such a manner on internal predisposing tendencies as to determine by direct modification the evolution of new specific forms. Furthermore he affirms that, beyond the domains of merely physical science (which, though much, is not everything), reason demands a non-mechanical conception—namely, the conception of an immanent active principle or soul in everything which lives. And he contends that between the self-conscious reason of man and the mere sensuous feeling of the higher brutes, there is a great and impassable gulf fixed. These are among the more important positions which the author of these "Essays and Criticisms" assumes in the field of biological speculation. And to these may, perhaps, be added his condemnation of the doctrine of the relativity of knowledge, and his belief in common-sense realism, apparently on the assumption that the external reality of the objective world (as opposed to its *phenomenal* existence) is directly apprehended by the intellect, though it cannot be reached through sensuous feeling.

On all these matters Dr. Mivart has much that is interesting to say, and says it in an interesting manner. It would manifestly be impossible here to discuss so wide a range of problems. We therefore propose to select one matter—that of the relation of human reason to brute intelligence—on which to offer a few remarks.

In the essay entitled "A Limit to Evolution," the author seeks to establish the impossibility of mental evolution as applied to man. He insists, and rightly insists, that the great difference between man and the lower animals lies not in his bodily but in his mental constitution; and he contends, again in our opinion with perfect justice, that in order to examine this question we must begin by looking a little carefully into our own minds, and by examining our own acts and mental nature. As the result of this examination he finds that our psychical operations fall into two classes; on the one hand, there are feeling (sensitivity), imagination and sensuous memory, sensuous emotion, sense-perception, and sensuous inference; on the other hand, there are intellectual perception, ideation and conception, abstract ideas, and moral and æsthetic concepts. "The contrast, the difference of *kind*," he says, "which exists between this *intellectual conception* and the various forms of *feeling* is very great." We thus possess a dual psychical nature, on the one side sensuous, on the other side intellectual. The sense-perceptions of the one and the abstract ideas of the other "belong to utterly different categories, and a nature which has this power of abstraction is separated from any nature which has *not* that power, by a gulf which is an impassable *limit to evolution*, because feeling and intellect are both thus different in nature, and progress and develop along different and more or less diverging roads." But the psychical powers of brutes are limited to sense-perception, and give no evidence of the possession of the higher faculty of ideation and conception. Therefore the passage from the so-called mind of the brute to the conceptual mind of man is not only impossible but inconceivable.

Such in brief is Dr. Mivart's line of argument. Now, we hold that the distinction between the higher self-conscious, reflective, and conceptual powers of man, and his lower sensuous, non-reflective, and perceptual mental activities is a valid and valuable one, and one which is too often lost sight of. And we hold, further, that our author is right, in the main if not entirely, in denying to brutes the higher powers of conceptual thought. Again, we agree with Dr. Mivart in regarding the progress and development of sense-perception and abstract thought as more or less divergent. Where we part company with him is in the assumption, for such it appears to us, that these divergent lines of development cannot have a common origin. In all that he has written on the subject we fail to find any adequate justification for this dogmatic assertion so often and so confidently reiterated. The distinction between mere sense-perception and reflective thought is frequently drawn with admirable lucidity and clearness; but the impossibility of their having a common psychical root is merely asserted with a few rhetorical flourishes. We venture to question the assertion. Dr. Mivart is not, be it noted, content to assume the modest but perfectly legitimate scientific position that no one has yet succeeded in showing the early stages of the divergence, the tentative beginnings of the reflective process, the gradual focussing of the mental eye upon the processes of consciousness. He does not take his stand on a "not proven," but on a somewhat dogmatic "impossible"—not merely an "impossible" to this or that or the other factor in evolution from the nature of the factor, but broadly and generally an Impossible that is as worthy of a big initial letter as the Unknowable itself!

We cannot take leave of Dr. Mivart's volumes without again calling attention to the fact that they are full of matter interesting to the student of evolution. His scientific conclusions are not altogether those to which we have ourselves been led, though there are not a few matters on which we have the pleasure of agreeing with him; his psychological and philosophical views are not in all respects those which we have reached, though here again we are on many not unimportant questions on his side; but we believe him to be an honest and fearless inquirer after that Truth which stands on the title-page of a work to which, perhaps, for some of our readers, these volumes of essays may form a suitable introduction.

C. LL. M.

PHYSICAL OPTICS.

A Treatise on Physical Optics. By A. B. Basset, M.A., F.R.S. (Cambridge: Deighton, Bell, and Co., 1892.)

A NEW treatise on the higher branches of physical optics must be welcome to all who are interested in the subject. Mr. Basset explains in the preface the scope and aim of his book, and it is needless to say that he performs the task he has set himself with ability and success. If, nevertheless, we close the book with a feeling of disappointment, it is because we could have wished that the author had been more ambitious, and attempted to give us a little more than a compilation of the standard papers on the subject. There is one sentence in the preface which, though it evidently does not express what the author meant to say, yet may serve as a peg whereon to hang the only criticism which can fairly be raised against Mr. Basset's treatment of his subject. "I have a profound distrust," says the author, "of vague and obscure arguments based upon general reasoning instead of upon rigorous mathematical analysis." Now, if we are to have vague and obscure arguments, it does not seem to matter much whether they are founded upon general reasoning or upon mathematical analysis, however rigorous that may be. In a subject which is in a state of growth, it may be possible to hide, but it is impossible to avoid, all obscurity and vagueness; and original work ever consists in the attempt to overcome such obscurities. By purposely excluding everything that is vague from a physical treatise, we destroy all possibility of making the work useful in stimulating further research. There are two ways of dealing with difficulties: we may try to overcome them, or we may run away from them. Mr. Basset chooses the latter course, and though some of us might have wished him to be a little more venturesome, we gratefully accept what he has given us, and the above remarks only apply to certain parts of the book. After an introductory chapter, Mr. Basset treats of the interference of light. He follows the time-honoured custom of taking Fresnel's mirrors and the biprism as the simplest case of interference. The effects which are observed are seriously modified, however, by so-called diffraction effects, and we might perhaps have expected a book of this kind to have entered a little more fully into the subject. That the author avoids all reference to experimental details is a distinct advantage, and renders his book more lucid and valuable for reference. It is much to be wished the author's plan could be more generally followed, and that all lengthy discussions of instrumental details could be kept out of theoretical treatises, and relegated to separate books.

The diffraction of light is fully discussed in chapters iv., v., and xiii. Mr. Basset has followed safe guides in the treatment of his subject, and it is perhaps this part of the book which will be specially valuable to the teacher and student.

It is well that the phenomena of double refraction should be first approached without more allusion to the difficult subject of the constitution of the ether than is absolutely necessary, and this is perhaps most easily done by following, as Mr. Basset does, the historical method, and starting from Fresnel's deductions.

The colours of crystalline plates are, of course, treated in an important chapter, and it is worthy of note that Mr. Basset does not introduce the somewhat misleading distinction between the effects produced by parallel and by convergent or divergent beams. In the usual polariscopes a number of parallel beams pass through the crystalline plate in different directions. If the optical arrangement between the plate and the eye is such that these various beams enter the eye, we get the phenomena which are often called interference effects in divergent light, while if those beams only which make a small angle with each other are allowed to pass the pupil, we get the uniform tint described as the effect of parallel light. Both kinds of effects might also be produced if instead of parallel beams we had a number of pencils diverging from points in a plane close to the crystalline plate. In either case the eye is supposed to focus for an infinite distance, and the different appearance is only one of degree, depending on the extent of the angle between the different rays passing through the crystal and into the eye.

Mr. Basset enters fully into the consequences of the various hypotheses which have been made as regards the differences of density or elasticity of the ether in different media. The investigations referred to by him are, of course, of the utmost importance, but it should have been pointed out that as regards application to optics they are wanting in reality. We know enough now to be able to say that the medium does not behave like an elastic body, and in some form or other the electro-magnetic theory must be considered as established. It seems idle, therefore, to discuss whether the hypothesis of Green or of Neumann is most contradicted by experiment. It would have been perhaps worth while to bring out more clearly the fact that *no* elastic theory of the ether has yet been found satisfactory, and that if the electro-magnetic theory had not come to help us we should be in a very serious difficulty.

It is true, of course, that we are at present unable, and probably always shall remain unable, to discard the elastic theories, because the study of transverse vibrations can only be satisfactorily carried out with the help of examples in which we understand to some extent the mechanism by which the vibrations are propagated. But unless a writer chooses to follow a purely historical treatment, it would seem to be more satisfactory to separate completely the mathematical study of vibrations from the subject of optics. Treated purely as elastic vibrations we may usefully discuss what would happen at the boundary between two media having different elasticities or densities;

and such a discussion, though independent of optics, would be certain to have important applications in it, because its results would often still apply when translated into language of the electro-magnetic theory. The mathematical investigation of vibrations might be made more clear and definite when it is freed from the necessity of adapting itself to experimental verification.

Chapter xviii. is a useful one, dealing with "theories based on the mutual reaction between ether and matter," but we might have wished for a more satisfactory introduction to the electro-magnetic theory that is given in the last two chapters. The way in which the subject is approached may illustrate some of the remarks made in the beginning of this review. There is no doubt a very serious difficulty in explaining the fundamental notions underlying the theory, and Mr. Basset, instead of making an attempt to help the student over the difficulty, suddenly plunges into a series of equations, referring us to Maxwell's book for an explanation even of his symbols.

We have perhaps given an inadequate idea of the contents of Mr. Basset's book, which no doubt lends itself to criticism from the physicist's point of view, but which nevertheless fills a gap and possesses merits which will render it of great value to the student of optics.

Arthur Schuster.

THE APODIDÆ.

The Apodidæ: a Morphological Study. By H. M. Bernard, M.A. Cantab. (London: Macmillan, 1892.)

THE title of this little book is misleading. It is not a treatise on the Apodidæ, but a statement of the author's speculations on the relations of the Phyllopodous Crustacea and Branchiate Arachnida to the Chætopod Worms. The new observations recorded are few, and the most important, that as to the presumed hermaphroditism of *Apus cancriformis*, quite insufficiently set forth, and, so far as can be judged from the author's meagre statement, erroneous.

Mr. Bernard appears to be completely misinformed as to current views on the relationships of Apus to other Crustacea, and of that group, through it, to the parapodiate worms. Apparently he addresses himself to a lay audience, and poses, to start with, as the discoverer of a new and unsuspected agreement between the lower Crustacea and the Chætopoda. This may serve to excite the interest of uninstructed readers, but the zoologist knows that such pretensions are due either to defective acquaintance with the subject or to a want of candour on Mr. Bernard's part. The arguments by which Mr. Bernard endeavours to support his thesis are, many of them, those which have been effectively used by his predecessors in the same cause; others are new and remarkable only for their arbitrary character and the evidence which they give of the author's boldness in writing a book on a morphological problem. Mr. Bernard draws attention to the absence of developed articulations in the limbs of Apus as giving them a resemblance to the parapodia of Chætopoda. He states that this absence "has already been pointed out by Lankester and others, but its true significance does not seem to have been noticed." This is an incorrect allusion to my essays on the appendages and nervous system of Apus (*Q. J. Micr. Sci.*, 1881), and on Limulus an Arachnid (*ibid.*), which is the more to be regretted since they appear to have furnished Mr. Bernard with such of his theories as well as his facts as will bear examination. At p. 368, *loc. cit.*, my statement runs—

> "I have long been of the opinion which Prof. Claus appears to hold, that the appendages of the Arthropoda are homologous (or, to use a more distinctive term, 'homogenous') with the appendages of the Chætopoda, and on this account I consider it a proper step in classification to associate the Chætopoda with the Arthropoda and Rotifera in one large phylum—the Appendiculata."

Yet Mr. Bernard comes forward to tell us that he now for the first time draws attention to the true significance of the absence of articulations in the limbs of Apus, although (as he admits) this condition was especially noted and very carefully described eleven years ago by me in the same essay in which the above paragraph as to the relationship of Arthropoda and Chætopoda occurs. This is a sample of Mr. Bernard's method of claiming novelty for what he has to say when dealing with old materials. Frequently he asserts in strong language novel propositions which are purely speculative and of the truth of which no evidence is adduced. There is in no part of this little book any evidence that the author has made use of living or of well-preserved material, or has had any special opportunities of studying the genera and species of Apodidæ; nor does it appear that he has any experience as a zoologist which might give some weight to his fanciful conceptions. On the contrary, these crude speculations and dogmatic assertions are his first original contributions to zoological literature. I regret to be obliged to say that in my opinion (which I am called upon to express candidly in these pages) "The Apodidæ" is not a book which can be recommended either as a repository of fact or as a model of the method in which a morphological problem should be attacked.

E. Ray Lankester.

OUR BOOK SHELF.

Anatomy, Physiology, Morphology, and Development of the Blow-fly (Calliphora erythrocephala). Part III. By B. Thompson Lowne, F.R.C.S., F.L.S. (London: R. H. Porter, 1892.)

We have before us another section of Mr. Lowne's work, which has grown upon the author's hands, and will form two volumes instead of the one originally intended. Part iii. is occupied with the internal anatomy of the imago, embryonic development, histology, and the development of the imago. On each of these heads a great amount of information is supplied, and the author's statements are illustrated by many figures. As to the puzzling question of the way in which the alimentary canal of the blow-fly is developed, Mr. Lowne holds an opinion which is probably shared with no second person. What Voeltzkow and Graber take to be the proctodæum, and what Korschelt and Heider believe to be the amniotic cavity, Mr. Lowne calls archenteron. He is content, as he tells us in his preface, to await the verdict of posterity on such conclusions as this. We are content to wait too. The subject is too difficult for full consideration in this place, and it would be unfair to express a strong opinion without ample discussion of the evidence. It is not unfair, we think, to characterize many of Mr. Lowne's morphological speculations as simple mistakes. To compare an insect-embryo and its membranes with a Lamellibranch or an Ascidian in the extempore manner assumed so lightly by Mr. Lowne (p. 244) is not creditable. He tells us that he has no facts to guide him except the similarity of the form and disposition of the parts. Any reader who is not able to judge for himself should be very much on his guard when our author mentions Vertebrates or Ascidians, or indeed any other animals outside the class of Insects.

It is painful to speak with any disrespect of an author so laborious and so independent as Mr. Lowne. But these good qualities do not suffice to make a really good book. Advice will probably be thrown away, but we will offer one hint in the most friendly way. If Mr. Lowne before going to press would get his sheets revised by any cautious and well-informed zoologist, he would be saved from making statements which seriously impair his work.

L. C. M.

A Mendip Valley: its Inhabitants and Surroundings. By Theodore Compton. With Original Illustrations by Edward Theodore Compton. (London: Edward Stanford, 1891.)

This is an enlarged and revised edition of the well-known "Winscombe Sketches," and will be cordially welcomed by readers who can appreciate the presentation of natural facts in a poetic spirit. The author has spent the greater part of "thirty-three years of rural life" in the valley about which he writes, and every aspect of it he knows and loves. He tells much that is interesting, not only about the valley itself, but about the people who inhabit it, and about its archæological remains, its wild beasts, past and present, its birds, fish, reptiles, butterflies, and flowers. The style is simple and clear, and a certain charm is added to the writer's descriptions by the quaint reflections with which many of them are associated. An excellent chapter on the geological history of the Mendips is contributed by Prof. Lloyd Morgan. The illustrations are daintily conceived and executed, and harmonize well with the general tone of the text.

Key to Elementary Dynamics. By S. L. Loney, M.A. (Cambridge University Press, 1892.)

Those who are using the author's Elementary Treatise, whether they be teachers or students, will find this key very useful. The solutions to the examples are here worked out in full, so that even one who is going through the subject by himself will learn much in the nature of attacking problems by direct methods. The author's treatise is now so widely used that this key will come as a great boon to many.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

The Lightning Spectrum.

During the brilliant display of lightning on the evening of June 28, I took the opportunity of making some observations of the spectrum. The way in which the spectrum varied was very remarkable, some of the flashes giving apparently perfectly continuous spectra, while others gave a spectrum of bright lines, as already recorded by Kundt and others. The continuous spectrum appeared to be associated with the flashes of longest duration, which were accompanied by very little thunder, and the bright line spectrum with the more instantaneous flashes. Using a Liveing direct-vision spectroscope with a very accurate scale, I succeeded in measuring the positions of six lines in the green, all of which no doubt have been *observed* before, but in two cases at least the *positions* have not been previously measured. The wave-lengths of the lines observed were as follows—those determined by Vogel, Schuster, and Colonel John Herschel, being added for comparison:—

	Schuster.	Vogel.	Herschel.	Remarks.
(1) 5002	—	5002	5009	Brightest line
(2) 5168	5160	—	—	Rather dim
—	5182	5184	—	—
(3) 5350	5334	5341	—	Fairly bright
(4) 5430	—	—	—	Rather dim
(5) 5515	—	—	—	Fairly bright
—	5592	—	—	—
(6) 5675	—	—	—	Fairly bright

Other lines were seen both in the red and blue, but time did not permit any accurate determinations of their positions.

The lines (1) and (6) are undoubtedly the two brightest double lines of the air spectrum which occur in this region, but in the case of the other lines the coincidences are not so definite. The proximity of the line 5168 to the brightest carbon fluting (λ 5165) would suggest that it has its origin in the carbonic acid gas, which is always present in the atmosphere. The remaining lines do not appear to coincide with air lines, and their origins for the present are undetermined.

A. Fowler.

Royal College of Science, South Kensington.

On the Line Spectra of the Elements.

Prof. Runge has not improved the position he has taken up by the new instance of a motion which he brings forward in last week's Nature. The instance he gave in his preceding letter is a motion which, as I pointed out, could not take place within molecules. The motion he now gives is one which cannot even exist anywhere in nature. It would require a supply of power (energy per unit of time) increasing *ad infinitum*. The first instance he gave belongs to inapplicable kinematics, his new one to impossible dynamics. Neither has anything to do with the subject of my memoir.

He quotes the enunciation of a theorem from chapter iv. of my paper, but does not quote the sentence introducing that theorem, which would have made it plain that the motions spoken of in it are *motions which can take place within molecules and which can produce an undulation in the ether*, not the motions of a mere mathematical exercise irrespective of whether they are real or imaginary. The introductory sentence (p. 588) is in the following words:—"The motions of the electrons, the electric charges in the molecules, which are what excite the ethereal undulation, may be motions that are not confined to one plane. Accordingly *to study them* we must investigate what theorem corresponds to Fourier's theorem when the motion takes place along a line of double curvature." And then follows the demonstration and the enunciation quoted by Prof. Runge. In the foregoing words, in the introductory paragraphs of chapter iv. of my memoir, and in other passages scattered up and down through that chapter, I made it abundantly clear, as I thought, that I was dealing throughout *with a real physical problem of nature*, not engaging in mere mathematical exercises that travel into the infinite and impossible. I now see that I ought to have made more explicit statements upon this point for readers who would judge of each sentence apart from its context.

In order that a motion, $x = f(t)$, may be susceptible of treatment by Fourier's theorem, the following are conditions that must be fulfilled:—

1°. The motion must be recurrent, or capable of being approximated to by recurrent motions.

2°. The quantity represented by x must not become infinite.

3°. The quantity represented by t must not retreat.

I have been familiar with these limitations since I was a student, more than forty years ago. *They are known to all students.* I therefore thought it superfluous, and still think it ought to have been superfluous, to state them in my memoir. I thought it also irrelevant, *since none of the limitations could occur in the motions I was investigating*; and I wished to shorten my memoir by excluding all irrelevant matter. Prof. Runge, however, objects that I have not treated of violations of the first two of these conditions. He has not yet said that I ought also to have discussed the impossible dynamics in which the third condition would be violated.

This, however, was not his original position. He began (see his original article, NATURE, April 28, p. 607) by supposing that a motion from which light emanated cannot, if non-periodic, be investigated by Fourier's theorem; and he stated that in consequence of this he could not understand the decomposition of the motion of an electron within a molecule into a series of superposed elliptic motions. In NATURE for May 12, p. 29, and for June 9, p. 126, I demonstrated in two different ways that his supposition was a mistake. The other objection made in his original article, viz. that "a plausible suggestion about the movement of the molecules ought to explain more," is also a mistake. These are the two condemnations passed on my paper in his original article. Both these have been met. And the issues he has since raised are, I again submit, not *legitimate* criticism of a physical inquiry. To make them legitimate he would need to produce an instance of a motion *of the kind with which my paper deals* (*i.e.* a motion that can produce a spectrum) and which at the same time is not amenable to the method of analysis given in chapter iv. of my memoir. This he cannot do, for there are no such motions. In fact, the analysis effected by the spectroscope is *identical* with a part of that made by Fourier's theorem when applied in the way that I there point out. The spectroscope gives the periodic times in the different partials, the sum of the squares of their principal axes, and in some cases their forms; but it does not give the phases of the motions in them or the planes in which they lie. Prof. Runge almost admits that his criticisms do not succeed in impugning the value of my memoir as a contribution towards our knowledge of nature, for in his last letter he says, "I do not say, therefore, that Prof. Stoney's views on the cause of the line-spectra are wrong." This is very different from what he said in April.

G. JOHNSTONE STONEY.

9, Palmerston Park, Dublin,
July 17.

"The Grammar of Science."

MAY I, through your columns, point out to Prof. Pearson what seems to me a serious "antinomy," to use his own phrase, in his "Grammar of Science." The foundation of the whole book is the proposition that since we cannot directly apprehend anything but sense-impressions, therefore the things we commonly speak of as objective, or external to ourselves, and their variations, are nothing but groups of sense-impressions and sequences of such groups. But Prof. Pearson admits the existence of other consciousnesses than his own, not only by implication in addressing his book to them, but explicitly in many passages. He says (p. 59): "Another man's consciousness, however, can never, it is said, be directly perceived by sense-impression; I can only *infer* its existence from the apparent similarity of our nervous systems, from observing the same hesitation in his case as in my own between sense-impression and exertion, and from the similarity between his activities and my own."

With respect to the argument from the "similarity of our nervous systems," I may point out, *en passant*, that however many other people's nervous systems Prof. Pearson may have dissected, he has certainly never dissected his own, and that therefore this argument, which is several times repeated in the book, is worthless; all Prof. Pearson has to go upon is the external similarity of other people's bodies and activities to his own. But he maintains that our bodies and their activities are nothing but groups and sequences of sense-impressions. Consequently, if other consciousnesses are similar to his own, some of his groups of sense-impressions possess private consciousnesses, which themselves receive sense-impressions, among which, for example, are to be found Prof. Pearson himself! Thus Prof. Pearson's consciousness contains a number of parts, each of which contains, amongst other things, Prof. Pearson and his consciousness! Of course it would be impossible thus to refute a consistent idealist, who maintained that not only external things but all other consciousnesses were unreal and existed only in his imagination; but to recognize the reality of other consciousnesses is to recognize the reality of the means by which we become aware of them, which, as Prof. Pearson explicitly states, is the external aspect of men's bodies.

It is not difficult to find the way out of this difficulty. It is that, though we do not *know*, *i.e.* directly apprehend, anything about the external world but sense-impressions, yet in order to explain those impressions we frame the hypotheses of external, objective reality, and of the "ejective" reality of other consciousnesses, and since these hypotheses are successful in explaining most of our sense-impressions, we have come to believe that they are true. Indeed, I cannot seriously doubt that Prof. Pearson himself believes in them as much as anyone else. Only, if he were to acknowledge it explicitly, he would have to rewrite almost every page of "The Grammar of Science."

EDWARD T. DIXON.

12 Barkston Mansions, South Kensington,
July 14.

PROF. KARL PEARSON'S "Grammar" merits more justice than it has received from "C. G. K." It is a remarkable book which I have read with much interest. He tells us (p. 15) that "the unity of science consists alone in its method, not in its material," and therefore the method employed in this work on science acquires a special interest.

There are two points in respect to which his method seems to me to call for a few remarks—remarks which cannot be unwelcome, since his motto is "La critique est la vie de la science."

The first point concerns his own position and that of certain persons he freely criticizes. The Professor has scant patience with metaphysics, and says not a few hard things of those tiresome people the metaphysicians; and yet his own book is really a metaphysical treatise and he turns out himself to be an unconscious metaphysician *malgré lui*. This fact can hardly surprise anyone who has mastered what is really the scientific A B C; but in the present instance it is peculiarly amusing. For he, with great *naïveté*, ridicules Prof. Tait for being in the very same case. He is styled (p. 296) "the unconscious metaphysician, who groups sense-impressions and supposes them to flow as properties from something beyond the sphere of perception"; and we are further told that "the unconscious metaphysics of Prof. Tait occur on nearly every page of his treatment of the fundamental concepts of physical science."

The second point which seems to require notice is the way in which his method plays "fast and loose" both with the system he upholds and the system he most opposes.

He is an idealist of a kind. Again and again we are told that scientific laws are but descriptions of our feelings in conceptual shorthand. He speaks (p. 129) of "the whole of *ordered* nature" being "seen as the product of one mind—the only mind with which we are acquainted," and he tells us plainly (p. 130) that "the mind is absolutely confined within its nerve-exchange; beyond the walls of sense-impression it can logically infer nothing." It would be easy to multiply such quotations.

Now, of course the idealist can logically make use of ordinary language in describing co-existences and successions between his feelings. The Professor's distinctions (p. 114) between "physical and metaphysical supersensuousness" have been duly noted, as also his disclaimer (p. 57) of giving any real explanation of the physical side of thought. Nevertheless, none of these considerations appear to me to justify his dogmatic mode of speaking of things of which the senses can take no cognizance.

If he knows nothing but his own feelings, he cannot reasonably speak of their mode of formation, or of the manner in which one group of feelings acts upon another. Yet, referring to a sensory nerve, he writes (p. 51): "The *manner* [the italics are mine] in which this nerve conveys its message is, without doubt, physical," and (p. 81) "Beyond the brain terminals of the sensory nerves we cannot get." Stars are for him but "groups of feelings," and yet he writes about them as follows: "Among the myriad planetary systems we see on a clear night, there surely *must be* myriad planets which have reached our own stage of development, and teem, or have teemed, with human life" (p. 179).

Speaking of waves (p. 305) he tells us, "The wave *forms* for us a group of sense-impressions." But the wave is, for him, *itself* a group of self-impressions and so is a particle of protoplasm. Nevertheless he speaks (p. 413) of the probability that long stages of development preceded its existence, and "of the millions of years, with complex and varying conditions of temperature," needed in order "to pass from the chemical *substance* of life to that complex *structure* which may have been the first stage of organic being." He also declares (p. 425) the belief that "the evolution of organic nature is at the basis of human history is the *unswerving belief* of the present writer."

My present object is not to object to any of these statements, but simply to call attention to the complete accord which exists between the Professor's language and that of realism, or any of the materialists whose sayings he sometimes deprecates, and to note the practical outcome of such teaching as that of his metaphysical "Grammar."

Its Idealism is an Idealism of parade, to be brought out occasionally, above all to confound some rash or inexperienced advocate of Intellectualism and Common-sense. But ordinarily and habitually it most certainly is, as "C. G. K." affirms (NATURE, July 7, p. 222), "distinctly materialistic." This teaching is an excellent example of that "intellectual thimble-rigging"—I use the illustration as an apt one, but in no invidious sense—to which I have elsewhere (see *On Truth*, p. 135) called attention in greater detail.

In conclusion I would ask how Prof. Pearson's metaphysical system can be necessary or even useful for the progress of science?

What does it matter for science, provided we are all agreed about those things whereof the senses can take cognizance, whether or not we are convinced that something extended exists objectively? The Professor affirms (p. 215) that the man of science "refuses to project his conceptions, atom and ether, into the real world of perceptions until he has perceived them there." We are then so far agreed. We both welcome ether units, prime atoms, chemical atoms, molecules, molecular motion, ether rings, ether squirts, &c., as admirably useful working hypotheses, but not as things to be yet regarded as objective realities. If I am right, the utility for science of much of the Grammar is not easily to be recognized. But it has a very distinct metaphysical utility for the opponents of the system Prof. Pearson favours, and will no doubt meet with grateful recognition at the hands of some of them.

ST. GEORGE MIVART.

Hurstcote, July 16.

A "Viper" Bite.

As cases of poisoning from the bite of venomous reptiles are happily rare in this country, it may prove interesting to some of your readers if I relate my experience on this matter.

About a month ago I caught two snakes at Bickleigh, near Plymouth, and whilst examining one it "bit" or rather struck me on the lower part of the right thumb. I immediately sucked the puncture (it could not be called a wound) which bled a little, and tried to make light of the matter. A livid patch soon formed round the point, and the hand and arm commenced to swell. In a quarter of an hour I was unable to hold anything, and almost in a fainting condition. The first symptom (apart from the swelling) was a peculiar taste and a sensation of swelling in the teeth, then the tongue commenced to swell and became so large that I could hardly move it, my eyes seemed ready to start from their sockets.

In half an hour a terrible vomiting commenced, preceded by excruciating pains in the stomach and heart, and continued with the pains altogether for nine hours, every drop of liquid being ejected almost as soon as swallowed; there was also violent purging and complete suppression of urine.

There was practically no pain in the arm; altogether the painful symptoms lasted for about nine hours.

I did not lose consciousness at any time. The arm continued to swell for two days, and then it was nearly as large as my leg. After this the swelling subsided, but the arm did not return to its normal size until twelve days after the accident. After the swelling had gone I suffered very much from rheumatical pains, and in fact do so now, and the digestion was also very much impaired. The viper is a male, a little more than two feet long, and about one inch in diameter at the largest part. Colour, a dull yellowish brown on the upper side, with a zigzag black line running down the whole length. On the under side it is nearly black except at head, where it is pale yellow. I have kept the reptile now for nearly five weeks, and although well supplied with small frogs, &c., it has not eaten anything, and seems as lively as ever.

Cases of this kind, where the sufferer is able to record the symptoms, being rather unusual, is my excuse for occupying the space of NATURE.

Plymouth. W. A. RUDGE.

THE EDINBURGH MEETING OF THE BRITISH ASSOCIATION.

THE Association has already met three times in Edinburgh, in 1834, in 1850, and in 1871. With the success of the 1871 meeting fresh in the memories of many citizens, the Town Council and other public bodies have entered cordially into the local arrangements for the meeting. The local committee formed some twelve months ago and its sub-committees have been actively at work, and everything is now practically ready for the reception of the Association.

The number of members of the Association who have indicated their intention of being present, and of new members who have already joined, are such as to show that the meeting will be an exceptionally large one. More than fifty distinguished foreigners have accepted the invitation of the local committee to attend the meeting.

Reception and Section Rooms.—The reception rooms are in Parliament-square, adjacent to St. Giles' Cathedral and the City Chambers. The Parliament Hall, the various court rooms, the rooms of the Society of Advocates, and the new library and hall of the Solicitors before the Supreme Courts have been placed at the disposal of the committee, and have been so appropriated as to constitute an ideal suite of reception rooms, including secretaries' and treasurer's offices, post, telegraph, and telephone office, ticket office, enquiry office, reading room, writing room, ladies' boudoir, smoke room, and refreshment buffet. Many of the rooms lend themselves to decoration, and the arrangements are as excellent in taste as in convenience. The Section Rooms are all in the University buildings; Sections A, E, F and G in the old buildings, and B, C, D and H in the new buildings. These buildings are about two minutes' walk from one another, and about four from the reception rooms. The section rooms are all well adapted for the purposes of the meetings, and in connection with each there is ample accommodation for committee meetings, while provision has been made for the occasional subdivision of some of the sections. In the new University buildings a room has been set apart for a temporary museum, in which objects of interest, which are brought under the notice of any of the sections, may be afterwards placed so as to be more easily inspected than is possible during the meeting of the section. It is expected that this will prove a valued addition to the convenience of the meeting.

While light refreshments may be had at the buffet in the reception rooms, the principal luncheon room will be found in the Students' Union Club, situated between the new and old University buildings. In the club there will also be a ladies' room, smoking-room, billiard-room, &c.

Lectures and Entertainments.—The programme for the evenings will follow the usual lines:—On Wednesday Sir Archibald Geikie will assume the presidency and deliver an address; on Thursday, the Lord Provost, Magistrates and Town Council invite members and Associates to a *conversazione* in the Museum of Science and Art; the Lord Provost will receive and welcome guests to the City. On Friday, Prof. Milnes Marshall will lecture on "Pedigrees"; on Saturday, Prof. Vernon Boys will lecture to artizans on "The Photography of Flying Bullets"; on Monday, Prof. Ewing will lecture on "Magnetic Induction," and on Tuesday there will be a *conversazione* in the Music Hall on the invitation of the local committee.

Military bands will play in the Princes Street Gardens every afternoon during the meeting, and there will be organ recitals in the "Reid" music class-room. Afternoon entertainments will be given by the Royal Scottish Geographical Society, the Rector and Masters of the Edinburgh Academy, and by others.

Arrangements have also been made to form parties to visit Edinburgh Castle, Holyrood Palace, and Arthur's Seat; these visits will be in the afternoon.

Excursions.—The committee have prepared a long list of excursions. Among those for Saturday afternoon are geological excursions to North Berwick and Tantallon, and to the Pentland Hills; a botanical excursion to Gullane; a dredging excursion on the Firth of Forth; and excursions to such places of interest as the Land of Scott, the Fairfield Shipbuilding Works and Glasgow, the Pumpherston Oil Works, Dundee and the Firth of Tay, Stirling, Rosslyn, Dalmeny and the Forth Bridge, Newbattle Abbey, and Dalkeith Palace.

On Thursday, occasion is taken to visit places of interest further afield. St. Andrews, Dunkeld, Scone and Murthly (arboricultural), Croy (archæological), Dobbs Linn Moffat (geological), Moorfoot Waterworks, Hamilton Palace, Drumlanrig, Yarrow, Crieff, the Trossachs, Loch Lomond, the Firth of Clyde, are all brought within the limit of a one-day excursion.

Many of the more important manufacturing and other works in the city and neighbourhood are to be open to members, who will thus have ample opportunity of becoming acquainted with the trade of the district. Visits to the paper works at Penicuik or Currie, to the printing-ink works at Granton, and to the gunpowder mills at Roslin, will form pleasant short afternoon excursions. The printing offices of Edinburgh are of great interest, and many of them have made arrangements for the reception of visitors. Breweries, distilleries, biscuit factories, and hydraulic engineering works have all their special developments here, and are well worthy of visits.

Hospitality and Lodgings.—Perhaps the greatest difficulty that the local committee has had to face has been the date fixed for the visit of the Association. August is *the* holiday month in Edinburgh, and under ordinary circumstances the residential parts of the town are during that month entirely in the hands of the police. For many of the citizens, indeed, holidays are possible only in August. It has therefore been matter of congratulation to the committee dealing with this part of the work to find that many people intend to remain in town during the meeting of the Association and that they have been informed of a large number of offers of hospitality having been sent to visitors.

The hotel accommodation in Edinburgh is considerable, but the strain upon it in August is great. The local committee have secured for members of the Association a considerable number of rooms in hotels, and these are being rapidly allotted on application. Visitors who intend to live in hotels during the meeting will do well to make their arrangements early.

With regard to lodgings, probably no town is so well off as Edinburgh, and fortunately during August many of the best rooms are vacant. A register of lodgings has been opened at the local offices, and the secretaries are prepared to give assistance to visitors desiring to secure apartments. A provisional list of hotels and lodgings has been prepared and may be had on application. The principal clubs have offered to admit visiting members of the Association as honorary members during the meeting, subject to such conditions as are required by the constitution of the club.

Publications.—The programme of local arrangements will contain a hotel map of Edinburgh, a large scale map of central Edinburgh, including all the buildings used in connection with the meeting of the Association, and a general map of Edinburgh and Leith, on which all the works open to visitors are specially marked.

The "Excursions Handbook," published by the committee, gives details of the various transit arrangements and general sketches of the routes to be taken. It also indicates the nature of the interest attached to each excursion. The handbook will be illustrated by a special map of the South of Scotland and by section maps on a larger scale showing details of excursions.

F. GRANT OGILVIE.

THE ORIGIN OF LAND ANIMALS: A BIOLOGICAL RESEARCH.[1]

THIS remarkable and very unequal work, many-sided and heterogeneous, is worthy of careful consideration. It is not wanting in imagination, more or less disciplined, and it is loaded with information from the works of contemporary naturalists, now for the first time brought together in a single volume. One great merit it has of regarding plants and animals, not merely as forms of life, but as living forms: the machinery is exhibited to us in motion.

The title of the work scarcely conveys an adequate idea of its comprehensiveness; it might just as well have been styled "The Evolution of the Living World [for plants are not excluded from its universal purview], and the way it has been brought about."

The leading idea appears to be that a change from marine to terrestrial habitat has taken place much earlier in the history of the higher forms of life than is generally supposed, that the land from the early beginnings of geologic time has been peopled both with animals and plants, and has, more than the sea, been the great arena of progressive change. At the outset, the shore, where sea and land and air all meet and commingle, was the birthplace of life, and from it living forms have continually wandered in all directions—to the open ocean and the abyssal depths, to rivers, marshes, and dry land. From the Algæ, which are almost the only marine plants, the vegetable kingdom was derived. That this is characteristically terrestrial is due to the fact that vegetable protoplasm is less adaptive than animal. "Plants as land proprietors are the true conservatives;" hence, once on land always on land. The terrestrial character of plants offers a suggestive hint as to the place of development of the greater part of the animal kingdom: it also has been on land, but with more numerous offshoots to the sea. In terrestrial plants such as Myxomycetes—"the true Bathybius"—are the roots of the animal world; or if this claim be not admitted, and to Bacteria be assigned this place, a terrestrial origin remains unimpugned, since these organisms are predominantly inhabitants of the land.

The migration of marine animals may be direct, but more usually it is by successive stages, first through fresh water—"the great highway to land-life"—then to damp places, and finally to the dry land itself, which, however, at the time of migration may have been subjected to a damper and warmer climate than at present prevails. With change of medium progressive modification has been associated, for existence in the air makes three great demands on the organism, it must protect itself against being dried up, acquire new modes of respiration, and more substantial organs of support.

Many animals, ennobled by their response to these demands, have returned to the sea, and exercise dominion over it, undergoing, of course, fresh modifications, particularly of the respiratory organs; while others have retained possession of the terrestrial domain, adapting themselves to minor changes of habitat and climate. Thus far more groups of land-animals are derived from a terrestrial ancestry than we imagine, and the next-of-kin of orders now characteristically marine are less frequently than we suppose to be found in the sea, but must be sought for on the land. The whale and sea-turtle, land crabs and climbing fish, so far from being rare and exceptional cases, are instructive examples of great migratory movements and associated anatomical change.

The hypothesis not only supplies a needed stimulus, powerful enough to account for the evolution of the organic world, but at the same time it explains the futility of our search in marine strata for connecting links between leading types of life, since the most critical steps in evolution have been taken on the land, and terrestrial fossils are of the rarest occurrence.

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[1] "Die Entstehung der Landtiere: ein Biologischer Versuch." Von Dr. Heinrich Simroth, Privat-docent an der Universität, Leipzig. Pp. 492, with 254 Illustrations in the Text. (1891.)

In illustration we may select the author's treatment of the Arthropoda, which have their origin in some ancient Annelid, probably a marine Polychæte, and not an Oligochæte, since no Arthropod possesses the red blood which the Oligochæta have acquired as an adaptation to land life.

The absence of cilia and a thoroughgoing chitinization, which are the most striking peculiarity of the Arthropoda, are a direct adaptation to land life; the chitinous envelope furnishing on the one hand protection against desiccation, and on the other organs of support, whilst its extensive development necessarily involves the disappearance of cilia, and the development of fresh contrivances for respiration.

Another important character common to the Arthropoda is the transverse striation of the muscle fibre; but transverse striation is generally admitted to be correlated with excessive functional activity, from which, according to the author, it results. Encase an animal in chitin, and its movements will, from the mechanical conditions of the case, be "acrobatic,"—to move at all it must move strenuously, by this excessive exercise transverse striation will develope in all the voluntary muscles, and "by correlation" in those of the alimentary canal as well. So much is the author impressed by the cogency of this reasoning that he regards the striation of the musculature as a direct indication of the terrestrial origin of the animal possessing it, and ventures to apply this formula to Sagitta, the direct development of which he gives as an additional argument for its descent from some terrestrial species.

The parapodia of the Annelida naturally gave rise to the appendages of the Arthropods, and it was while these were still short, scarcely-jointed stumps that the Trilobites branched off in one direction, converting all their parapodia into legs, and the Scorpions and Merostomes, which discarded their abdominal appendages, in another. The Crustacea, retaining like the Trilobites all their appendages, branched off at about the same level, and their connection with the Arachnida is confirmed by Jaworowski's recent observation of the exopodital and endopodital splitting of the appendages in Tarentula. A confirmation of the terrestrial habitat of the primitive Crustacea is suggested by the fact that the most archaic existing forms are the Branchiopoda, which still live in fresh-water and salt marshes, can survive drying up, and indeed seem to require it for the production of sexual eggs. The remarkable diversity of the respiratory organs in the Crustacea is another important piece of evidence, since it points to their having been acquired as secondary adaptations.

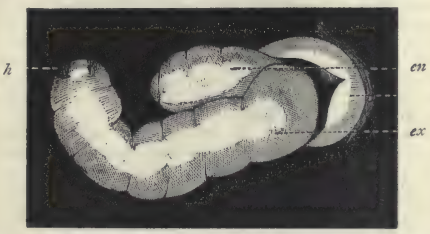

Fig. 1.—Pedipalp of an embryo of *Trochosa singoriensis*; *en*, endopodite; *ex*, exopodite; *h*, hairs (after Jaworowski).

Of Arachnoid forms, some entered the sea, probably the majority of the Merostomata and the Xiphosura, but Limulus still gives evidence of its original home, since it comes to the shore for begetting, and lays its eggs at the highest tide-mark.

No doubt the notion that the immediate ancestors of Limulus were land animals will excite scorn in prejudiced minds; but it is one that Balfour long ago suggested (the author does not seem to be aware of this), led to it probably by his recognition of the close relationship between Limulus and the Arachnoids on the one hand, and the Arachnoids and Insects on the other—the latter connection lately so much strengthened by Jaworowski's remarkable discovery of rudimentary antennæ in Tarentula. In this direction may be looked for a reconciliation of the views of Lankester and Lang.

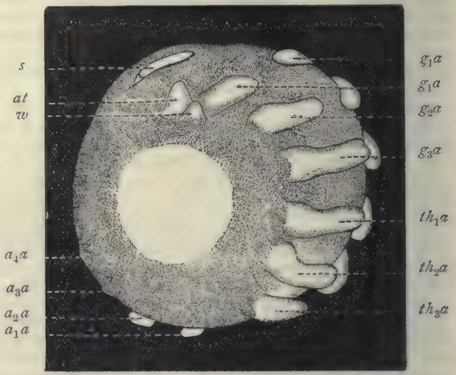

Fig. 2.

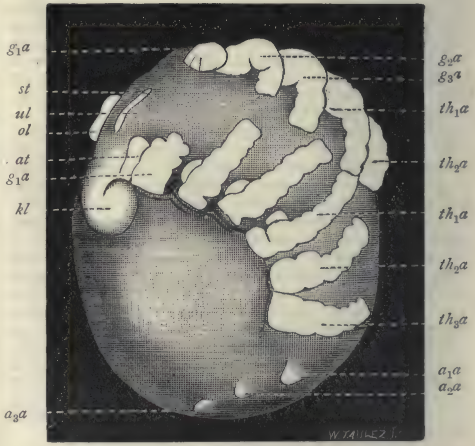

Fig. 3.

The mild surprise with which we learn that Trilobites and Crustacea were originally denizens of the land has scarcely given place to conviction before we encounter the chapter on fishes. We shall be prepared to find that these can claim terrestrial ancestry too. The earliest fossil vertebrates of which we know anything are the Placoderms; these were dwellers in the Old Red Sandstone lakes, and, as our author remarks, "from fresh water to the land is only a step." That the Placoderms were well able to take this step is proved by the character of their pectoral limbs, which, unlike the fins of fish, are provided with a transverse joint in the middle—"an elbow joint"; and this, while clearly helpful in walking, would not be well fitted for swimming. No doubt the animal was also a swimmer; the dorsal fin shows so much, but it was also a walker, travelling over hard, uneven ground; indeed, to this habit is attributable the turning up of the tail-fin (!), which formed the third point of support. A drawing, subscribed "original," representing Pterichthys "as it might have moved," is so full of unconscious humour that we are tempted to reproduce it. From such amphibious primitive vertebrates the fish branched off in one direction and descended to the sea—the swimming-bladder represents the original lung; in another direction proceeded the Stegocephala, the ancestors of reptiles, birds, and mammals. Primarily the Vertebrata are derived from Annelids, but the claim put forward for the Placoderms is more in harmony with Patten's view, connecting them with the Arachnoids; for the grave difficulties which beset this view, however, let Smith Woodward's trenchant criticisms be considered.

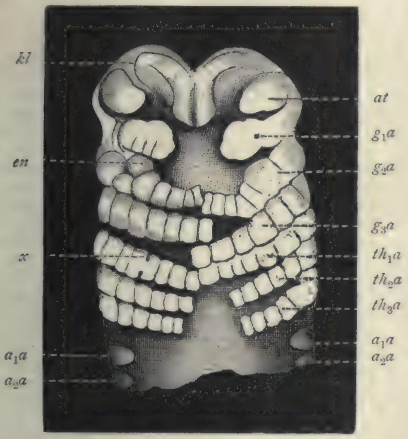

FIG. 4.

FIGS. 2 to 4.—Embryos of *Trochosa singoriensis*. Fig. 2 on the 13th day. Figs. 3 and 4 on the 15th day; Fig 4, the anterior end seen *en face*. *st*, stomatodæum; *kl*, frontal lobes; *ol*, upper and *ul*, lower lip; *at*, antennae; *w*, wall-like thickening of marginal groove; g_1a, chelicerae; g_2a, pedipalp; g_3a, 1st pair of limbs; th_1a-th_3a, thoracic appendages (2nd to 4th pairs of limbs); a_1a-a_4a, abdominal appendages; *x*, a deep constriction; *en*, rudiment of endopodite (after Jaworowski).

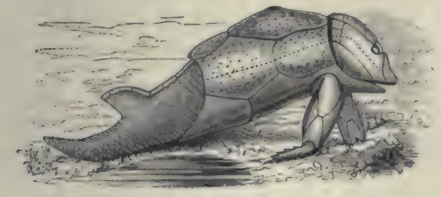

FIG. 5.—*Pterichthys*, as it might have moved. (Original.)

The main line of argument is followed into a number of collateral branches, all elaborately discussed. There is a powerful chapter on the strand fauna, in which are arrayed the great host of marine animals, including fishes, which temporarily leave the sea to breathe the air. This is regarded as a fact of profound significance, indicating a general tendency of the strand fauna to come on shore.

Recent investigations by Zacharias, Nusbaum, Chun, and others are made good use of in discussing the distribution of fresh-water fauna. Aërial transport, particularly by birds, is accepted as accounting for most of the facts. The survival of the transported forms is insured by the chitinous investment either of the animals themselves or more usually of their eggs. It is pointed out that most pelagic fresh-water species are provided with means of attachment: such are the spines of pelagic species of Daphnia, the abdominal processes of Bythotrephus, and the singular antennæ of Bosmina. Copepods which lay eggs which sink to the bottom are restricted in distribution; those which carry them about in egg-sacs are world-wide.

An attempt is made to prove that fresh water opposes some obstacle to the secretion of carbonate of lime; and though a comparison of the thickness of marine and fresh-water shells is far from bearing this out, yet some interesting results are elicited; as, for instance, the suggestion that the chitinous bristles of the young of *Paludina vivipara* are probably the last traces of originally calcareous spines.

In illustration of the various stages of land life, the Testacillidæ are cited as an interesting example of adaptation to a terricolous existence. *Daudebardia*, one of the family, begins life as a form precisely like a *Hyalina*, but with growth passes through the successive stages shewn in the figure (fig. 6) till it becomes the worm-like adult.

A good deal of space is naturally devoted to the subject of encystment, which is regarded as a protection against desiccation. In the course of this discussion an earlier origin is attributed to the Heliozoa than to the Radiolaria, since they do not possess the central capsule of the latter, which are consistently regarded as the marine descendants of an ancient fresh-water group related to Heliozoa. The suggestion is added that the withdrawal of plasma in the Radiolaria into the central capsule as a preliminary to spore formation is not really with a view to this event, but a reminiscence of encystment, which occurred in ancestral fresh-water forms. Bald suggestions such as this, and another which occurs in the work, to the effect that chlorophyll first acquired its fluorescence as the primæval sky cleared of clouds and permitted an extension of the solar light towards the violet end of the spectrum, should, from motives of prudence, have been omitted. A total *bouleversement* of accepted views on main lines of descent is sufficient for a great work without the added irritation of superfluous conjectures. Summer and winter eggs belong more or less to the question of encystment, and the author regards winter eggs as "an adaptation to small pools, and threatened destruction by drying up." This, like the statement that the chitinous shells of the eggs of pelagic Crustaceans were acquired as a protection against desiccation during their aërial flight, might have been expected from an ultra-Darwinian, but in an author who wishes to explain evolution by physical causes, and not by chance, it is less pardonable. "An adaptation to threatened drying up" is an expression which would please the metaphysicians, who have lately been contending that an effect may precede its cause.

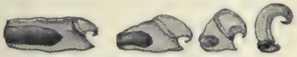

FIG. 6.—*Daudebardia* in different stages of growth; on the right, youngest, on the left, oldest stages. The buccal mass is shaded. (Original.)

The bibliography at the end of the work will be found most useful, especially to Englishmen, who will find in it a guide to a great deal of interesting German literature; but it is without form, and this to a great extent is true of the work itself. There are citations to the number of 423, and more, not numbered, yet, although we have a long discussion on the relationship of Limulus to Scorpion, Lankester's work is not mentioned; with chapters on fresh-water faunas, no allusion to "The Origin of Fresh-water Faunas," by Sollas; W. Marshall, a German author, is set forward in the text as an authority on pelagic and coast faunas, and Moseley overlooked; titles are sometimes given without place or date of publication, a defect which becomes serious when periodical literature is referred to without mention of volume. The illustrations are numerous and excellent.

The author has produced a fresh and promising thought, but one cannot help regretting that he did not wait—like, say, Darwin—till it was full time for bringing forth.

W. J. SOLLAS.

THE PHOTOGRAPHIC MAP OF THE HEAVENS.[1]

THE first number of the second volume of papers published under the auspices of the Permanent Committee charged with the execution of the photographic map of the sky has made its appearance at a sad moment in the history of the undertaking. For simultaneously with its appearance is announced the death of him who, more than any other man, has contributed to its success, and brought it within the range of practical science. Admiral Mouchez has known how to secure not only the active co-operation of many astronomers, but also how to make them zealous in the great work, the arrangement of the details of which has occupied the last years of his life. He has awakened enthusiasm for the success of his scheme, and smoothed many difficulties which might have hindered its progress, and probably few undertakings of equal magnitude and equal importance, breaking new ground in many directions, have been got under way with less friction and fewer disappointments. We may well hope that the same sauvity and diplomacy which has characterized the conduct of the late Director of the Paris Observatory will be found in the counsels of his successor, and that a work begun in so much hope will be carried to a successful issue.

The papers in the volume before us can be brought roughly under two heads, both, notwithstanding the lapse of time from the inception of the scheme, betokening an initial stage in the preparation. One of the topics under discussion has for its aim the selection of a method which shall secure on the photographic plates, destined ultimately to furnish a catalogue, the impression of stars of the eleventh magnitude with certainty and uniformity; the other, a means of deriving the co-ordinates of the star images so impressed with the greatest facility and sufficient accuracy.

To deal with the second of these proposals first, we may remind our readers that whatever method of measuring the positions of stars on a plate may be adopted, the resulting co-ordinates must be purely differential, and probably referred to the axes of the réseau impressed upon the plate as a latent image, and developed under the same conditions as the stars themselves. To pass to the determination of R.A. and declination, a great deal of information, entirely independent of photography, will have to be made available. The readiest means of effecting this last step in the reduction, as it appeared to a committee of experts appointed to consider this question, was to determine by meridian instruments the absolute co-ordinates of six stars on each plate. It is needless to comment upon the magnitude of the labour thus undertaken, or at least contemplated. This preliminary work would demand a catalogue of some sixty or seventy thousand stars, most of them below the ninth magnitude and not found in existing catalogues. In order to give to each determination the necessary accuracy, it is desirable that each star should be observed twice in both elements and at two observatories. When we remember the length of time that the re-observation of Argelander's zones has consumed, and is still incomplete, we can form some estimate of the time that must inevitably elapse before the results of the photographic catalogue can be made available for astronomical purposes.

In presence of these difficulties, and many more which occur to the practical astronomer, we must be very grateful to M. Loewy for elaborating a scheme which, if it be found practicable, will materially shorten the time necessary for the production of the catalogue. M. Loewy proposes to avail himself of the fact that the plates are taken in two series, in such a manner that each corner of a plate in one series will form the centre of four other plates in the second series. When, therefore, the astronomer has determined the rectilinear co-ordinates of the stars on *one* plate relatively to the central lines of the réseau, each of these stars will belong in common to the plate considered, and to one of the four plates of the second series, partially covering the first. M. Loewy's scheme consists in making the stars on the four plates thus connected available for the reduction of the first. And, on paper at least, it is not difficult to extend the scheme still further, and to make the plates contiguous to these four contribute to the reduction of the original plate by means of an extended triangulation. In this way a plate would not be considered as an isolated fact, but a considerable area, of 36, 64, 100 or more square degrees could be woven into a harmonious scheme of reduction. And such a plan possesses this very obvious advantage, that on even a lesser area, as of 36 square degrees, we may well expect to meet a sufficient number of bright stars whose places are already so well determined that the reduction of the plates could go on immediately without waiting for the observations of the stars on the meridian. And independently of this evident advantage, it seems highly probable that two of the elements of reduction, viz. the orientation of the plate, and the value of the scale, will be determined more accurately, if the stars which are used for the derivation of these corrections are separated by a considerable distance, that is greater than a single negative would permit.

M. Loewy considers the various sources of errors and their necessary correction with all the detail required to submit the plan to practical application, and this is precisely the test that is needed. This appears to be also the opinion of Dr. Gill, expressed in a very cautious approval of M. Loewy's scheme, and he further quotes a remark of Prof. Auwers, which contains a very salutary caution. That astronomer points out that the reduction of the catalogue plates will be most accurately effected from the position of *faint* stars, rather than from bright ones. In that case since our present most accurate catalogues do not give the positions of the fainter stars, those catalogues will still need to be supplemented by many meridian observations. Dr. Sande Bakhuyzen, however, expresses the opinion that the zones of the *Astronomische Gesellschaft* will, when completed, furnish the necessary data for all reductions, or, at most, require additional observations in some portions of the sky, which he is able to point out from a careful examination of the number of the stars contained in these zones.

The second topic which has received much consideration in this volume is, as before mentioned, the adoption of a method to secure the registration of stars of the eleventh magnitude. It will be remembered that the International Congress of 1891 proposed to place in front of the object glass of the telescope, screens of fine metallic gauze, identical in manufacture, and of such construction that the amount of light impeded should be equivalent to two magnitudes: the coefficient 2·512 being employed as the ratio to express the relative brilliancy between two consecutive magnitudes. A committee was appointed to carry this plan into execution, but the report which this Committee has issued is unfavourable to the adoption of the method. The signatures of the Astronomer Royal, Prof. Pritchard, and the brothers Henry, are attached to this report; but M. Vogel, the remaining member of the Committee, has not found the reasons assigned by his colleagues sufficient to warrant the rejection of the scheme, and consequently his name does not appear. The President of the Permanent Committee thus sums up the case against the proposal. Light in traversing a metallic screen of bright threads and very narrow mesh, seems to experience, besides the ordinary effects of diffraction, certain modifications, whose cause is not yet explained, and which the Congress could not foresee when they framed the recommendation. This peculiar behaviour of the light demands further study, and renders the application of this means very difficult, if not useless, for the purpose for which it was proposed, since the discrepancies of the results obtained are greater than the error that an experienced astronomer would make in estimating stars of the eleventh magnitude.

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[1] "Bulletin du Comité International Permanent," tome ii., premier fascicule.

The experiments on which this conclusion is founded are set out in considerable detail, and a careful study of these experiments ought to convince an unprejudiced critic that the committee was justified in advising the rejection of the screens as an adequate and efficient means of deciding upon stars of the eleventh magnitude. It should be stated that the gauze screens, identical in character, were furnished by Prof. Vogel, and though there is no mention of the experiments or processes which induced the Potsdam astronomers to select a screen of this particular obstructive power, it is to be presumed that in his photographic telescope they stopped the amount of light proposed by the Congress. It is not the least curious feature in the discussion (controversy would be far too strong a word to describe the courteous paragraphs in which the various astronomers set forth their reasons for dissent from the able physicist), that Prof. Vogel takes no part in it nor vouchsafes any information as to the principles by which he was guided in the selection, but leaves the onus of rejection entirely to his colleagues, who are thus placed at a disadvantage.

Prof. Pritchard, whose photometric researches permit him to speak with authority, has stated concisely the result of his experience. He found that on the ordinary astronomical telescope, achromatised presumably for D, the amount of light obstructed was equivalent to 2·4 mag., and on the photographic telescope, with a minimum focal length for G, the amount of light lost was not less than 2·8 mag. The Astronomer-Royal reports that the action of the screen on the Greenwich telescope is to stop 2·5 mag. This result was deduced by comparing the seventh and ninth magnitude stars of Argelander. Some further comparisons of the obstructed and unobstructed light of stars of the ninth and eleventh magnitude photometrically examined by Prof. Pritchard with the wedge photometer confirmed this result, and further proved that the scale of Pritchard and Argelander was in very satisfactory and close agreement. It will be necessary to return to this point. M. Henry at Paris offers results in close accordance with those of the two English astronomers just quoted. He finds that the screen proposed by M. Vogel as effective in his instrument stops between 2·5 and 2·7 mag. on the Paris telescope, and this effect is still further confirmed by some observations by M. Trépied, while M. Rayet at Bordeaux finds 2·7 mag. represents the effective action of the screen. Very different is the experience of M. Donner, of Helsingfors. His method of estimating the loss of light is different from that employed in the other cases, and is perhaps not without objection, but the result which he derives from his observations is that the light of a star in passing through the screen loses only 1·6 mag.

It is now necessary to describe very briefly the methods employed in the various observatories which have led to these discordant results, the more so as one eminent authority, Dr. Dunér, of Lund, who apparently holds a brief for Prof. Vogel, has taken exception to the results deduced. Leaving on one side the experiments conducted by MM. Henry and Trépied on artificial stars, and against which Dr. Dunér urges no objection further than that they are founded on artificial stars, we find that one principle pervades the examination conducted at Greenwich, Paris, Bordeaux, and Algiers. The several astronomers have determined what length of time is necessary to produce a blackened star disc of the same diameter from the same star with and without the screen. In this way it has been found necessary to expose for ten or eleven times as long with the screen before the object glass as without, and from this fact it has been inferred that the loss of light occasioned by the screen amounts to 2·5 or 2·6 mag. It is urged that if only two magnitudes were lost by obstruction, the necessary exposure would have been $(2{\cdot}512)^2 = 6{\cdot}3$, that required by the unobstructed object glass. Dr. Dunér remarks on this that those who have condemned the employment of the screens on these grounds have argued in a vicious circle, and to be logically correct it would be necessary to show that the intensity varies as the time of exposure or

$$it = \text{const.}$$

Against the accuracy of this law Dr. Dunér urges that reports of the observers themselves show three distinct proofs. In the first place (1) Dr. Donner states that only 0·58 mag. is gained by successively multiplying the length of exposure by 2·5; (2) that the Astronomer Royal proves that a gain of 1·7 or 1·85 mag. is secured by multiplying the length of exposure by 6·25; and (3) that MM. Henry have found that to obtain similar discs from stars of the 9·3 and 11·3 mag. the exposure has to be increased from 28sec. to 240sec. (1 : 8·6). These three experiments give instead of 2·512 respectively,

$$3{\cdot}28,\ 2{\cdot}69,\ 2{\cdot}93.$$

results apparently incompatible with the formula

$$it = \text{const.}$$

MM. Trépied and Henry reply at length and effectively to these strictures. They do not regard 2·69 and 2·93 as differing so greatly from 2·512 but that the discrepancy may be fully explained by inaccuracy and paucity of observations. The Helsingfors result (3·28) they refuse to accept as unequivocal evidence in the face of established facts. The method of Dr. Donner consisted in comparing photographs of the Pleiades, taken with and without the screen, with the map of M. Wolf, and marking the number and magnitude of the stars which have black or grey images. This method, as already hinted, does not seem to be entirely free from objection. Admitting that the comparison of the images was made, as we are sure it was, with all the care possible, there is still room for the varying exercise of individual judgment as to what constitutes a black and what a grey image, and the final result is likely to be less exact than a process based upon rigorous measurement.

The method employed by Prof. Pritchard is, perhaps, as free as any from objection or misinterpretation. He exposed the plate for *equal times* with and without the screen, and then measured the diameters of the resulting star discs. If two discs, produced, one with, and one without the screen, were found equal in diameter, then the effect of the screen is equivalent in photographic action to the original difference of magnitude between the two stars. This difference of magnitude was determined by the wedge photometer, and the only exception that can be taken to this determination is that the scale of the wedge photometer may not be accurately applicable. But here we have the distinct assertion of the Astronomer Royal, reiterated again by M. Trépied, that the Pritchard Argelander scales are in very satisfactory accord. This circumstance is the more gratifying for two reasons. First, because it is distinctly stipulated in resolution 19 (1889), "Chaque observateur devra s'attacher à obtenir sur ses clichés destinés au catalogue la grandeur 11·0 déterminée aussi exactement que possible *au moyen de l'échelle d'Argelander*." The maintenance, therefore, of the scale of Argelander becomes of paramount importance, and this one could scarcely hope to effect by means of the gauze screens. The second satisfactory point is, that Prof. Pritchard is endeavouring to secure uniformity in the photographed stars by distributing among the participating observatories small charts of particular regions of the sky on which are marked stars of the 9th and 11th magnitudes approximately. Naturally in the determination of the magnitudes of the stars on these charts, the scale of Argelander will be perpetuated, and inasmuch as the testimony of several astronomers is distinctly in favour of making use of these typical areas, it seems very probable that Argelander magnitudes will be prolonged in the catalogue work down to the faintest stars impressed.

NOTES.

The summer meeting of the Institution of Mechanical Engineers will be held in Portsmouth, and will begin on Tuesday, July 26. The following papers have been offered for reading and discussion, not necessarily in the order here given :—On shipbuilding in Portsmouth dockyard, by Mr. William H. White, F.R.S. ; on the applications of electricity in the Royal dockyards and navy, by Mr. Henry E. Deadman ; description of the lifting and hauling appliances in Portsmouth dockyard, by Mr. John T. Corner, R.N. ; description of the new Royal pier at Southampton, by Mr. James Lemon ; description of the Portsmouth sewage outfall works, by Sir Frederick Bramwell, F.R.S., Past-President ; description of the new floating bridge between Portsmouth and Gosport, by Mr. H. Graham Harris ; description of the Southampton sewage precipitation works and refuse destructor, by Mr. William B. G. Bennett ; description of the experimental apparatus and shaping machine for ship models at the Admiralty experiment works, Haslar, by Mr. R. Edmund Froude ; description of the pumping engines and water softening machinery at the Southampton water works, by Mr. William Matthews.

The half-yearly general meeting of the Scottish Meteorological Society was held at Edinburgh on Monday, July 18. The council of the society submitted its report ; and Dr. Buchan read a paper on variation in the annual rainfall in Scotland since 1800.

The Museums Association held its annual meeting in Manchester, at the Owens College, on July 5, 6, and 7, under the presidency of Prof. Boyd Dawkins, whose address we print elsewhere. Among those present at the meeting were Dr. Ward, Principal of Owens College, Prof. Flower, Prof. Miall, the Rev. Canon Hicks, Prof. Milnes Marshall, the Rev. H. H. Higgins, and Prof. Weiss. Mr. J. Willis Clark, the retiring president, was unfortunately prevented from attending. The following papers were read and discussed :—On the arrangement of botanical museums, by Prof. F. E. Weiss.—On the cultivation of special features in museums, by the Rev. H. H. Higgins.—Local museums of art and history, by the Rev. Canon Hicks.—On the Manchester Art Museum, by Mr. T. C. Horsfall.—On the preparation of picture catalogues, by Mr. Butler Wood.—On the colouring of the background of museum cases, by Mr. Edgar R. Waite.—On the best means of preserving vegetable structures, and on a collection illustrating the life-histories of the British Lepidoptera, by Mr. J. W. Carr.—On the exclusion of dust, by Mr. T. Pridgin Teale ; and library and museum legislation, by Mr. E. Howarth. Mr. Pacy and Mr. Ogle, who had been deputed by the Libraries' Association to attend the meeting, took part in the discussion of the last paper. A Committee of the Museums' Association was appointed to confer with the Libraries' Association on the possibility of taking steps to improve library and museum legislation. Most of the members of the Museums' Association who took part in the discussion were of opinion that the restrictions at present placed upon the action of Town Councils with regard to libraries and museums were unnecessary and obsolete. The meeting was a very successful one, thanks to the energy and good management of Mr. W. E. Hoyle and Prof. Milnes Marshall. The reception accorded to the Association by the authorities of the Owens College was of the most cordial nature, and the Association is indebted to Dr. Ward and several of his colleagues for much kindness. It was agreed to hold the next annual meeting in London under the presidency of Prof. Flower.

Mr. William E. Plummer has been appointed by the Mersey Docks and Harbour Board, director of the Liverpool Observatory, in the room of Mr. J. Hartnup, deceased. Hitherto this Observatory has done little more than regulate chronometers required for the port of Liverpool, but we understand that the Observatory will now be reorganized and made to play a more active part in observational astronomy, and one worthier of the equipment of the Observatory and the generous support the board accord to it.

Dr. W. H. Ince, Ph.D. (Würzburg), Demonstrator of Chemistry in University College, Liverpool, has been appointed Demonstrator of Physics and Chemistry in the Medical School of St. Thomas's Hospital.

Mr. A. H. Leahy, M.A., Fellow of Pembroke College, Cambridge, has been elected to the Professorship of Mathematics at Firth College, Sheffield. Mr. Leahy is a Mathematical Lecturer and Junior Bursar of his College, and is the author of several important papers on mathematical physics.

Mr. R. Elliot Steel, Senior Science Master of the Bradford Grammar School, has been appointed by the Technical Instruction Committee of the Corporation of Plymouth to the Head Mastership of the Science Department of their new technical schools, Plymouth.

The Master and Wardens of the Drapers' Company of the City of London recently gave £3000 towards the erection of the new technical schools attached to the Nottingham University College, and have now given a further sum of £1000 towards their equipment.

"Cook's Tours" are well known all over the civilized world, and vast numbers of Englishmen have been indebted to them for some of the brightest and pleasantest experiences of their lives. Everyone, therefore, was sorry to hear of the death of Mr. Thomas Cook, the founder of the system. He died at Leicester on Monday in his eighty-fourth year. Mr. Cook was a man of immense energy, and may almost be said to have had a touch of genius. At all events he had a very remarkable faculty for organization, and did much to foster among the British public a just appreciation of the advantages to be derived from foreign travel. Last year the jubilee of his firm was celebrated.

The volcanic forces of Mount Etna have continued in a state of violent activity. On the afternoon of July 14 it was stated, in a Reuter's telegram from Catania, that there were then eighteen openings in the mountain, of which nine were active. "The lava," said the writer, "is flowing in the direction of Nicolosi at the rate of 50 yards an hour. It has already passed the deposit of lava formed by the eruption of 1886. The flow towards Pedara is less rapid. Every hour the devastation increases, and the alarm of the inhabitants grows in proportion. Their terror is not lessened by the explosions and rumblings proceeding from the volcano." On July 15 a Reuter's telegram from Catania stated that the eruption was that day more formidable than ever. "The main crater is extending in size, and the showers of stones and masses of molten matter are continually increasing in volume, some of the projectiles being carried to a height of 1000 feet. Meanwhile, two fresh cones, 800 feet in height, have been formed, and from these streams of lava are constantly flowing in the direction of Nicolosi, from which they are now only about two miles distant. No immediate danger threatens the inhabitants of the village, but the destruction caused to the surrounding country goes on increasing." On July 16 and 17 telegrams to a like effect were despatched. On the latter date, indeed, it was stated that the eruption had been less active on the previous night, and the reports of the internal explosions less frequent and not so loud; but the volcano continued to throw up enormous blocks of incandescent rock together with clouds of steam. The lava stream had reached the village of Venatura, where it had destroyed several houses, besides doing enormous damage to the adjacent chestnut woods. On the 18th it was announced from Catania that during the previous night loud rumblings had continued, and that the discharge from the craters of Mount Etna had increased in violence, stones and ashes being projected to a height of over 1200 feet. In the morning the subterranean noises were less frequent and not so loud. At Patagonia, besides the volcanic explosions proceeding from Mount Etna, subterranean rumblings had been heard, while in the neighbouring naphtha lake, and the fountains of Vachella, gaseous eruptions had occurred. On the 19th, although the smoke proceeding from the craters was less dense, the eruption continued with renewed violence. The subterranean rumblings were more frequent and of longer duration, but not so loud as during the previous days.

ON July 15 it was announced from Naples that Mount Vesuvius had become active, and that lava in large quantities was pouring down the part of the mountain called the Atrio del Cavallo.

DURING the latter part of last week the weather over these islands was much disturbed by the influence of a deep depression which lay over the Baltic. The temperature was below 60° in the northern and below 70° in the southern parts of the kingdom, and the rainfall exceeded an inch in the south of Ireland. At the close of the week another depression appeared over the Bay of Biscay, and spread over our southern districts, accompanied by rain, while owing to the northerly winds the temperature continued very low, the maxima scarcely exceeding 60° in any part. In London on Sunday it did not exceed 55°, which, with about one exception, is the lowest daily maximum in July during the last half-century. During Monday night a deep depression advanced over Scotland from the northward, and travelled south-eastwards, accompanied by heavy rain, while on Tuesday increasing winds or gales were experienced on all our coasts, the wind direction varying from N.E. to N.W. and W. According to the *Weekly Weather Report* the rainfall for the week ending the 16th instant was considerably less than the mean in all the northern districts, while over the eastern, central, and southern parts of the kingdom there was a considerable excess, the amount being in many cases more than double the mean for the week. Temperature was below the mean in all districts excepting the Channel Islands; in the eastern and central parts of England the deficiency for the week amounted to from four to six degrees.

LAST week two despatches were received at the Colonial Office from Mr. Jerningham, Acting Governor of Mauritius, relative to the recent hurricane there. Mr. Jerningham states that the lives lost through the disaster were 1230, and the number of wounded still living 3167. Over sixty-two churches and chapels had been damaged or wrecked, and there had been a partial and enforced cessation of the celebration of Divine service throughout the island. The number of public buildings injured was 123, and the damage done to Government property was estimated at 286,807 rupees. The injury to the railways would cost about 55,435 rupees to make good. All the telegraph wires throughout the island were destroyed. About 16,976 houses and huts had been destroyed or damaged, exclusive of those in Port Louis, and about 170 sugar factories had been wrecked or injured. The task of repairing these disasters was one of great magnitude, and wholly beyond the unaided power of the colony. A later despatch states that in Port Louis 1453 houses, churches, and public buildings, representing a value of nearly five million rupees, had been wholly or partially destroyed.

THE *Kew Bulletin* for May and June contains several contributions which will be of great interest to botanists and to various classes connected with the industrial applications of botany. One of these contributions is a valuable report (with a plate) by Mr. George Massee on a disease that has attacked vanilla plants in Seychelles. In the same number are printed the second of the Decades Kewenses Plantarum Novarum in Herbario Horti Regii conservatarum, and the second decade of new orchids. An excellent illustration of the way in which the authorities at Kew seek to promote industry is afforded by a correspondence on Sansevieria fibre from Somali-land. The increased attention devoted to the production of white rope fibres in the Western tropics appears to have had a stimulating effect in the East Indies, and now the production of fibre from *Agave vivipara* in Bombay and Manila is followed by a fibre obtained from Somaliland from a singular species of Sansevieria. This fibre was first received in this country as an "Aloe" fibre. It was soon noticed, however, that it possessed characteristics differing from all ordinary "Aloe" fibre, and a request was made to the Foreign Office that Colonel Stace should be invited to obtain for the Royal Gardens a small sample of the fibre, a large leaf from the plant yielding it, and, if possible, a few small plants for growing in the Kew collection. In due time the specimens arrived in excellent order, and it was found that the fibre is one of the many so-called Bow-string Hemps, and probably yielded by *Sansevieria Ehrenbergii*, a plant first collected by Dr. Schweinfürth. Little or nothing was known of it until it was described by Mr. J. J. Baker, F.R.S., in the Journal of the Linnean Society, vol. xiv., p. 549. Its locality is there stated as "between Athara and the Red Sea." The plant is described in a letter to the Foreign Office, written by Mr. D. Morris, as a very interesting one, and he adds that its existence as a source of a valuable supply of fibre will be sure to awaken attention among commercial men in Great Britain. Messrs. Ide and Christie, writing to Mr. Morris, speak of the fibre as an excellent one of fair length and with plenty of "life." "In character," they say, "it strongly resembles the best Sisal hemp, with which we should have classed it but for your statement that it is derived from Sansevieria. With the exception of its colour, its preparation is perfect, and even as it is, we value it to-day at £25 per ton. We are of opinion that if care were taken to improve the colour a considerably higher price would be readily attainable, perhaps as much as £50 per ton, if a pure white fibre could be attained without loss of strength and lustre."

Among the other contents of this number of the *Kew Bulletin* is an account of the fibre industry in the Bahamas, communicated to Kew by Sir Ambrose Shea, Governor of the Bahamas. Extracts from a report by Mr. A. White, a naturalist attached to the staff of Mr. H. H. Johnston, H.M.'s Commissioner and Consul-General for the territories under British influence to the north of the Zambesi, throw welcome light on the botany of Milanji in Nyassaland. Mr. N. E. Brown contributes notes on the botany of plants yielding Paraguay tea. There are also sections on the Nonnen pest in Bavaria, the prickly pear in Mexico, and the Palmyra bass fibre.

The collection of hardy bamboos and allied plants having outgrown the space allotted them in the beds near the Temperate House of the Royal Gardens, Kew, a new garden has been made for them in a wood near the Rhododendron Dell. Of this garden the *Kew Bulletin* gives the following account:—It is in the form of a shallow depression with sloping banks 12 feet wide and a central pear-shaped bed 125 feet by 75 feet. To make it, the surface soil had to be removed and the gravel taken out to a depth of about 3 feet. A large quantity of new soil and manure was added so that the bamboos have now a good depth of rich soil. Two new paths leading to the Bamboo Garden have been made, one from the Syon vista and the other from the Stafford walk. The bamboos planted in the garden are:—*Arundinaria Fortunei* (Bambusa Fortunei), *A. japonica* (Bambusa Metake), *Bambusa albo-striata*, *B. gracilis*, *B. nana* (Hort), *B. palmata*, *B. plicata*, *B. pumila*, *B. tessellata*, *B. Veitchii*, *Phyllostachys bambusoides*, *P. nigra*, *P. Quilloi* (Bambusa Quilloi), *P. violescens* (Bambusa violescens), *P. viridi-glaucescens* (Bambusa viridi-glaucescens), *Thamnocalamus Falconeri* (Bambusa Falconeri), and several others unnamed. Besides bamboos it contains such plants as *Arundo*, *Eulalia*, *Crinum*, *Funkia*, *Yucca*, &c. It is also intended to bring together in this garden a number of the coarser growing monocotyledonous plants which can be grown in the open air at Kew.

According to an official "Notification of the Trustees of the Schwestern Fröhlich Stiftung" at Vienna, certain donations and pensions will be granted from the funds of this charity this year in accordance with the will of the testatrix, Miss Anna Fröhlich, to deserving persons of talent who have distinguished themselves in any branch of science, art, or literature who may be in want of pecuniary support, either through accident, illness, or infirmity consequent upon old age. The grant of such temporary or permanent assistance in the form of donations or pensions is, according to the terms of the foundation deed, primarily intended for Austrian artists, literary men, and men of science, but foreigners of every nationality, English and other, may likewise participate, provided they are resident in Austria. Particulars may be obtained at the Austrian Embassy, London.

Mr. T. S. Shearmen, of Brantford, Canada, has recently issued a pamphlet, in which he claims priority in the discovery of the fact that the influence of sun-spots on terrestrial magnetic conditions depends upon the positions of the spots on the sun's disc as seen from the earth. He states that he has succeeded in convincing Prof. Young that this claim is justified. His observations have led him to believe that, in the great majority of cases, magnetic disturbances are most numerous when spots are at or near the eastern limb. In many cases, however, especially when the spots were very large, the disturbances have been greatest when the spots were near the central meridian; but even then it is stated that on nearly every occasion in which this has happened, another spot was making its appearance on the eastern limb. M. Veeder (Nature, vol. xlvi. p. 29) also concludes that in order for a solar disturbance to have its full magnetic effect upon the earth, it is necessary that it should be at the sun's eastern limb, and as nearly as possible in the plane of the earth's orbit.

In the tenth annual report of the Fishery Board for Scotland a striking instance is given of the advantage which persons engaged in the fishery industry derive from the electric telegraph. The Orkney officer reports that on Saturday morning, August 22, a large shoal of herrings was discovered about three to seven miles off the island of Stronsay by a few boats which happened to be at sea. Having ascertained the position of this shoal the officer wired the particulars, for the fishermen's information, to all the stations in Orkney. On the Monday following every boat employed in the herring fishery in Orkney was on the fishing ground indicated, with the result that the heaviest fishing ever obtained in one day in Orkney (for the number of boats employed) was landed on Tuesday, the average catch for the whole fleet being fifty crans. The number of boats fishing was 108, and their total catch was 5400 crans, valued at £3240, a large proportion of which would have been lost but for the telegraph. Wick fishermen having also been apprised of the circumstance, a number of the Caithness boats had good takes on the same ground and landed them at Wick. Consequent upon such a heavy and unexpected fishing, additional coopers, gutters, packers, barrels, and salt had to be immediately sent for from Wick so that the herrings might be cured while they were in a fresh state, and this was accomplished by means of the telegraph.

An interesting exhibit of tobacco will be sent from Kentucky to the Chicago Exhibition. There will be exhibits of different varieties of plants in various stages of growth, and illustrations of the manner of shipping and handling "the weed" from the time the seed is put in the ground until the final product is ready for use. The various ways in which tobacco is used in manufacture will also be illustrated.

During the last few years much has been said about the supposed European origin of the so-called Aryan race. The honour of having first suggested this theory is usually attributed to Dr. Latham, but, according to Dr. D. G. Brinton, it really belongs to Omalius d'Halloy. In *Science* (June 24), Dr. Brinton refers to a paper in the *Bulletins de l'Académie Royale de Belgique*, tome xv., No. 5, May, 1848, entitled "Observations sur la distribution ancienne des peuples de la race blanche," in which Omalius begins by speaking of a series of notes presented by him to the Academy from 1839 to 1844. In these notes he had sought to prove that the Asiatic origin of the white race had never been demonstrated. Having recorded this fact, he proceeds "to discuss the evidence, physiological, historical, and linguistic, which had been thought to show that the Indo-European peoples originated in Asia; and combats it at every point, marshalling his arguments to prove that the true white type is distinctly European; and that the ancient Sanscrit and Zend are in no wise maternal languages of the Indo-European stock, but merely sisters of the Greek, Latin, and ancient German." The earliest date at which Dr. Latham expressed similar views was 1851.

Some suggestive notes on Fuegian languages, by Dr. D. G. Brinton, were read lately before the American Philosophical Society. He refers to a very early Fuegian vocabulary, collected by the French navigator, Jouan de la Guilbaudière, during a sojourn of eleven months in the Straits of Magellan during the year 1695. It includes about three hundred words and short phrases, and no part of it has been published. The MS. copy of it in Dr. Brinton's possession he owes to the courtesy of M. Gabriel Marcel, the Librarian of the Geographical Section of the National Library of France. As M. Marcel intends to give it publicity in the Compte-rendu of the Congress of Americanists, Dr. Brinton contents himself with illustrating its character by a limited selection of words. These show that the basis of the tongue is Alikuluf, and it differs, he says, scarcely more from the Alikuluf of the present generation than do between themselves the vocabularies of that tongue by Fitzroy and Dr. Hyades in the present century. A few words belonging to the Tsoneca and the Yahgan may be detected, probably introduced by trading natives.

The new number of the Journal of the College of Science, Imperial University, Japan (vol. v., Part 1), contains studies on reproductive elements, by C. Ishikawa; further studies on the formation of the germinal layers in Chelonia, by K. Mitsukuri; papers on the development of *Limulus longispina*, and on the lateral eyes of the spider, by Kamakichi Kishinouye; a paper on the formation of the germinal layers in Petromyzon, by S. Hatta; and notes on a collection of birds from Tsushima, by I. Ijima. The papers are most carefully illustrated.

We have also received the second part of the first volume of "Iconographia Floræ Japonicæ," by Ryōkichi Yatabe (Tokyo: Z. B. Maruya and Co.). The work consists of descriptions, in Japanese, of plants indigenous to Japan, with figures.

Mr. T. E. Buckley contributes to the current number of the Annals of Scottish Natural History some interesting notes on the vertebrate fauna of Sutherland and Caithness. The object of the notes is to bring the fauna of these two countries up to date. One bird, the ruff, is new to the Sutherland list, and Mr. Buckley is able to show the spread of certain other species such as the stock dove, tree pipit, &c. Eagles still hold their ground fairly well, but other birds of prey show a decrease. This, the author thinks, is only what might be expected, but it is sad, he says, to see how the hen harrier is rapidly approaching extermination. Plantations are growing up, and increase the number and breeding areas of certain species. When staying at Badenoch, he has been repeatedly struck in the autumn with the attraction which a few (say three or four hundred) small firs, a garden, and an acre or two of cultivated ground, have for migrating birds. Constantly in the early October mornings he has seen flocks of small birds, such as greenfinches, chaffinches, &c., descend into these trees, rest for a short time, then, with an unanimous twitter, rise up and pursue their onward course. As a rule everything was quiet for the day by nine o'clock.

At the meeting of the Field Naturalists' Club of Victoria on May 9, Mr. T. S. Hall read an interesting note on musical sands. While on a trip to Phillip Island at Christmas time, Mr. Hall was struck by the musical note given out by the sea sand when walked over. He had never noticed this phenomenon before, though it occurs not uncommonly in other parts of the world. His first idea was that the sound was caused by the india-rubber soles of his shoes, but he found he could get the musical note by striking the sand with his hand, or by drawing a stick rapidly over the surface. The sound was produced only where the sand was dry, and resembled almost exactly that caused by drawing the finger rapidly over a piece of corded silk. On making the sound by skating over the surface, he found that the note could be detected at a distance of forty paces. The sands were musical wherever he tried them about Cowes, and the only person to whom he spoke who had noticed the phenomenon said he had also noticed it at San Remo. Mr. Hall has since tried the sand at Geelong, Barwon Heads and Warrnambool without any result. He referred to the theories of Mr. Carus-Wilson on the one hand, and Dr. A. A. Julien and Prof. H. C. Bolton on the other, and expressed a hope that some attention would be given to the subject in Australia.

In the latest quarterly statement of the Palestine Exploration Fund it is said that considerable progress is being made with the Akka-Damascus Railway, the route of which, after various expensive surveys, has been definitely decided upon. The line chosen is practically that first suggested by Major Conder, R.E., several years ago. Beginning at the great fortress of Acre, the railway will run down the plain of Acre parallel with the sea, throwing out a branch to Haifa, at the northern foot of Mount Carmel, and thence to and across the plain of Esdraelon, passing near Nazareth to Shunem and Jezreel, and through the valley of Jezreel, skirting the slope of the hills, to the River Jordan, which will be crossed within sight of Bethshean. The Jordan here offers exceptional facilities for the erection of the railway bridge, consisting of two spans. Not only are the two opposite banks of the river formed of solid rock, but the centre of the river contains a large block of similar rock, from which each span of the bridge will be thrown to the east and west bank respectively. From the Jordan the railway will ascend the slope of the Jaulan Plateau, along the crests that close the eastern shores of the Sea of Galilee, this ascent constituting the only difficult portion of the line, but which the surveys now made show to be much easier of accomplishment than was originally anticipated. The plateau near El 'Al being reached, an easy gradient will carry the line by Seil Nawa and Kesweh to Damascus. Passing through the finest plains of Western and Eastern Palestine, the railway will be one of great importance. The authorities of the Palestine Exploration Fund are of opinion that its construction can hardly fail to lead to important archæological discoveries, and the committee hope to make arrangements for obtaining full information respecting these.

The additions to the Zoological Society's Gardens during the past week include a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, presented by Major Day; two Red-handed Tamarins (*Midas rufimanus*) from Surinan, presented by Mr. J. J. Quelch, C.M.Z.S.; two Sœmmerring's Gazelles (*Gazella sœmmerringi* ♂ ♀), three Egyptian Gazelles (*Gazella dorcas* ♂ ♀ ♀) from Suakim, presented by Colonel Holled Smith, C.B.; a Red Deer (*Cervus elaphus*), European, presented by Mr. J. Newton Hayley; a Slender-billed Cockatoo (*Licmetis tenuirostris*) from South Australia, presented by Mrs. Duppa; a Rough-eyed Cayman (*Alligator sclerops*) from South America, presented by Dr. Rudyard; two Dwarf Chameleons (*Chamæleon pumilus*) from South Africa, presented by Mr. E. Windgate; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. J. Cornwall; two Green Lizards (*Lacerta viridis*), two Green Tree Frogs (*Hyla arborea*), European, presented by Count Pavoleri, F.Z.S.; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Mr. Conrad Kelsal; a West African Python (*Python sebæ*) from West Africa, received in exchange; six Mandarin Ducks (*Æx galericulata*), five Summer Ducks (*Æx sponsa*), seven Chilian Pintails (*Dafila spinicauda*), six Australian Wild Ducks (*Anas superciliosa*), a Variegated Sheldrake (*Tadorna variegata*), four Upland Geese (*Bernicla magellanica*), a Cheer Pheasant (*Phasianus wallichii*), a Himalayan Monaul (*Lophophorus impeyamus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

A New Nebulous Star.—Mr. Barnard, in *Astronomische Nachrichten*, No. 3101, gives a brief account of a new nebulous star that he found when photographing, on May 31 last, a region situated in the Milky Way, 18h. 10m., – 20°. This star (B.D. – 19°·4953), when examined (visually) with his 12-inch, was quite devoid of nebulosity owing to the brightness of the star in question, but the photograph showed a faint nebulosity of about 15′ in diameter symmetrically surrounding it. A former photograph taken in 1889, July 28, indicated also the same nebulosity. The exposure in the former case was of 3h. 29m. duration, a Willard lens of 6-inch aperture being used. The position of the star for 1860 was R.A. 18h. 9m. 23·2s., Decl. − 19° 42′·7.

ATMOSPHERIC DEPRESSIONS AND THEIR ANALOGY WITH THE MOVEMENTS OF SUN-SPOTS.—The solar photosphere, although so different in chemical composition from our own atmosphere, yet affords us many points of resemblance with regard to its general circulation. One special analogy, and that a comparison of the motions of storms here with those of spots on the solar surface, is treated of in the July number of *L'Astronomie* by M. Camille Flammarion. In this article he has brought together sufficient observations to trace out the paths of many of the most violent storms that have from time to time visited Europe generally. The first storms which he gives are those which occur in the Atlantic; their general direction of motion seems to be from south-west to north-east, pursuing generally the path of the Gulf Stream. Their centres, when traced on a map, seem to just graze the shores of the British Isles, France very rarely being reached by them. From observations made on land, and more especially from those at Paris, M. Flammarion remarks that certain curves with regard to these storms seem to offer many analogies to solar spots; this is so not only for the regular displacements, but even for those which at first sight seem to be totally void of all regularity. The diagrams which he gives, showing both the paths of the storms and those of sun-spots, afford most interesting comparisons and seem to confirm the view suggested by M. Faye that the constitution of spots resembles somewhat that of the cyclones with which we are familiar.

YALE COLLEGE OBSERVATORY REPORT.—In this report, submitted by the Board of Managers to the President and Fellows of the Yale Observatory, Mr. Brown makes us acquainted with the present condition of the Observatory generally, while Dr. Elkin gives an account of the work done by the heliometer during the past year. The satellites of Jupiter formed the principal object of work from July 1891 to January 1892, 570 complete measures of their relative positions having been obtained on 114 nights. Dr. Chase, with the same instrument, has been measuring the cluster in Coma Berenices, securing from 18 to 20 measures for each of the 32 stars, besides determining the required data for the reduction-constants. In the work on the parallaxes of the first-magnitude stars in the northern hemisphere, the 100 sets of measures of each of the ten stars have not yet been fully completed, but the following table shows the results obtained up to the present, Dr. Elkin thinking that it will require two more years before the final results can be published:—

Star.	Parallax.	Prob. Error.	No. of comp. stars.	No. of Sets.
	″	″		
α Tauri	+ 0·101	+ 0·022	6	65
α Aurigæ	+ 0·095	0·021	5	51
α Orionis	+ 0·022	0·022	6	48
α Canis Minoris	+ 0·341	0·020	6	48
β Geminorum	+ 0·057	0·021	6	48
α Leonis	+ 0·089	0·026	10	43
α Bootis	+ 0·016	0·018	10	89
α Lyræ	+ 0·092	0·019	6	67
α Aquilæ	+ 0·214	0·023	10	46
α Cygni	+ 0·012	0·020	7	49

GEOGRAPHICAL NOTES.

THE condition of affairs in Uganda, of which much has recently been made in home and foreign newspapers, is a question rather of politics than of geography; yet problems of a geographical kind are involved in it. So far the progress of civilization amongst the Waganda has served only to introduce new elements of dissension, and the attempts to carry out the policy of preventing the sale of spirits, firearms, and ammunition have only been partially successful. Scientific exploration in a country so unsettled must necessarily be suspended. If the British occupation is to be productive of benefit either to British trade on the one side or to native interests on the other, the firm and impartial rule of Captain Lugard and Captain Williams must be maintained and reinforced. The urgent request which these officers have made for additional white assistance demands all the more attention since the garrison under their control has been swelled by the survivors of Emin's force in Equatoria.

ALTHOUGH, as announced in NATURE (p. 230), Captain David Gray's Antarctic expedition has fallen through, it is satisfactory to know that three Dundee whalers, which are shortly expected back from the Arctic "fishing," will be refitted immediately and despatched about the beginning of September to the Falkland Islands, and as far to the south as may be necessary in order to get a cargo. The proposed cruise is to be purely commercial, and it is not likely that any exploring work will be done. It is probable that berths will be available on board for two or more scientific men, who should have good opportunities of collecting natural history specimens. The experience of the whale-ships will be valuable in supplying hints for the equipment and route of the great Antarctic expedition which under some European flag cannot be long delayed.

DR. OSCAR BAUMANN, charged with the survey of a road to the Victoria Nyanza, reached the shores of that lake in April, after an unprecedentedly rapid journey from the coast. From the *Times* report of a letter written by Dr. Baumann from Kadoto, we learn that the route, after passing around Lake Manyara, struck across an unknown stretch of country in which a new lake of large dimensions was discovered. Even in Africa few lakes of such magnitude can now remain unknown, at least from native reports. Lake Eiassi lies on the plateau south-east of Victoria Nyanza, and from the report of the neighbouring Masai, it seems to be about ninety miles long, while the breadth of the northern portion, along which Dr. Baumann marched, varied from eighteen to thirty miles. This lake is presumably filled with fresh water, but no outlet is mentioned. It is interesting, however, to find native reports of a great river flowing in on the western side, which may be confidently identified with the Wemberi, a river shown on recent maps as flowing north-eastward from the border heights of Unyamwesi, and losing itself on the plateau. It is possible that the new lake may discharge into the Victoria Nyanza by the Simiu river, the head waters of which have not previously been explored.

THE recently founded New Zealand Alpine Club has published the first number of its *Journal*, devoted to the exploration of the glaciers and peaks of the Southern Alps. The magnitude and difficulty of these snow mountains of the south has hitherto been very inadequately realized.

THE MUSEUM QUESTION.[1]

GENTLEMEN of the Museums Association,—In taking the chair which was so ably filled by my predecessor at Cambridge, I must first of all give you a hearty welcome on the part of the Committee of the Manchester Museum. There is to my mind a singular fitness in the selection of Manchester as a place of meeting after Cambridge. At Cambridge you had the opportunity of studying the various museums which have in the course of time naturally grown out of the development of that ancient seat of learning. In Manchester you will see the collections which have been gathered round Owens College, which represents the newest University development in this country. The genius of the place has left its mark in both. In Cambridge the collections are, as they should be in a region of academic calm, free from trade-winds, arranged mainly, if not entirely, with an eye to University students, and not for the general purposes of a miscellaneous public. In this busy centre of movement and commerce, you will find that the principle of arrangement is twofold. It first aims at meeting the needs of the University students, and of the Mechanics' Institutes, and schools, and other educational bodies, which are daily being drawn closer to Owens College, and next at the instruction and enjoyment of the general public. Our collections are for the most part older than the college and have been absorbed from without into our educational centre.

The problem which we have attempted to solve is this: How to arrange and organize collections which are in part as old as the second quarter of this century, so that they may become valuable in the new learning and at the same time put an outline of the history of nature within reach of the people. This problem, as we all know, is not an easy one. It has, however, to be faced in most of the museums of this country. Whether it has been solved or not in Manchester, it is not for me to say. Prof. Huxley, in addressing us some years ago on the question of technical education, said that he did not know exactly what shape it should take, but that Manchester was a good place in which to make an experiment for the good of the Commonweal. *Fiat experimentum in corpore Mancunensi.* The result of our experiment in museum organization is here and speaks for itself.

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[1] Address to the Museums Association, Manchester meeting 1892, by the President, Prof. Boyd Dawkins, F.R.S.

Before, however, I deal with this special attempt to meet the needs of Manchester I must touch on the general question of museums.

The Museum Idea and its Place in Culture.

A museum was to the Greeks a place haunted by the Muses, and in a secondary sense a building in which liberal studies were carried on such as that at Alexandria, which was a great University endowed by the State, divided into colleges, and frequented by men of science and letters. This museum included picture galleries and statuary, and it is not at all improbable that it contained also collections of Natural History. Aristotle, it must be noted, made vast collections, which he used in his history of animals, by the aid of his friend Alexander the Great, and it is hard to believe that the impulse which he gave to the study of natural history should not have been felt in Alexandria, where his memory was venerated. With the destruction of this museum in the days of Aurelian in the last quarter of the third century after Christ, the name as applied to a public institution gradually dropped out of use, and was only revived with the revival of learning in the West in the times of the Renascence. We owe the first idea of a great national museum of science and art to the "New Atlantis" of Lord Bacon, the first scientific museum in this country to Elias Ashmole, who founded the museum which bears his name in 1667 at Oxford. It consisted mainly of the natural history collections made by the Tradescants, and miscellaneous objects of antiquarian interest, which in the course of time swamped the natural history. Now, under the care of Mr. Arthur Evans, reorganized and rearranged, it is taking its place among the educational institutions of the University. It was not until 82 years after the foundation of the Ashmolean that museums were recognized by the Government of this country in the establishment of the British Museum in 1749 by Act of Parliament.

The modern museum is the outcome of the Renascence, and must keep pace with those great accessions to our knowledge of the history of Nature and of Man which distinguish the new from the old learning of to-day. If it cease to grow it is dead, and should be removed. There is no finality in museum work any more than there is finality in the acquisition of knowledge.

The Muses should not be forgotten in museum arrangements, and form, beauty, and symmetry should be studied as well as the outlines of a rigid classification. As an illustration of this I would refer to the groups of birds in the Natural History Museum at South Kensington, or to some of those in the museum at Newcastle. "A thing of beauty is a joy for ever." There is no reason why things beautiful in themselves should be treated so as to repel rather than attract. The element of fit association, too, is one of the important principles. In the case of the temporary exhibition of pictures in the Academy, the fit association of subjects cannot be studied, but there is no reason why in an art gallery the Muses should be scared by a Venus being placed close to local worthies, or a Madonna close to a party of Bacchanals. In museums as in armies the results are largely dependent on the leaders, who leave the impress of their personal character on their commands. The impulse to the new learning given by Ashmole, Hunter, Flower, and by Franks and Newton in this country, by Leidy, Dana, Marsh, and Agassiz in the United States, will last as long as the museums which they founded and organized. In Paris the name of Cuvier is inseparably bound up with the Museum of Natural History in the Jardin des Plantes. In Berlin the Ethnological Museum, and the anatomical collection at the Charité, will keep fresh the memory of Bastian and Virchow in a far distant future when the names of the great political leaders of these times are fading away. It is, therefore, of primary importance to choose good leaders for museum work, and to offer those inducements which will command the services of the best men.

The Old Local Museums in Britain.

When I first began to study the question, some thirty years ago, most of the local collections in this country were in a deplorable state. They consisted largely of miscellaneous objects huddled together with more or less care, and more or less—generally less—named. In one you saw a large plaster cast of a heathen divinity, surrounded by stuffed crocodiles, fossils, and models of Chinese junks, which looked like the offerings of devout worshippers. In another I remember a small glass case containing a fragment of human skull, labelled "human skull," and a piece of oatcake, labelled "oatcake," while underneath was a general label with the inscription, "A piece of human skull very much like a piece of oatcake." In a third wax models were exhibited of a pound weight of veal, pork, and mutton chops, codfish, turnips, parsnips, carrots, and potatoes, which must have cost the values of their originals fifty times over. They had labels explaining how much flesh and fat they would make—theoretically—for we who are either lean or fat know that the personal equation has to do with the actual results. They were as carefully modelled as the most delicate preparations of human anatomy. I quote them merely as illustrations of the misapplication of time, money, and museum space.

In many collections art was not separated from natural history, nor from ethnology, and the eye took in at a glance the picture of a local worthy, a big fossil, a few cups and saucers, a piece of cloth from the South Seas, a model of a machine, and probably also a mummy. These objects would be all very well in their places, but being matter in the wrong place, they were covered by the Palmerstonian definition of rubbish. Such collections as these neither please nor instruct. They have no more right to the name of a museum than a mob has to be called an army. Most of us, I think, are acquainted with this type of collection, which is rapidly becoming extinct with the spread of knowledge. I merely quote them as examples of a state of things from which we have fortunately escaped.

The Place of Museums in the New Learning.

The rapid increase of knowledge makes it more and more necessary for museums to be organized, so as to be in harmony with the swiftly changing conditions. The study of things as well as books is daily growing in importance. The historian, for example, formerly content with written records, now counts the results of archæological discovery among the most valuable and trustworthy of his materials in dealing with the history of the past. The story of Ancient Greece is incomplete if the explorations at Mykenæ and Ilios, in Athens, in the Greek islands, and in the Egyptian cities and tombs be left out of account. To the historian the collections of Schliemann, Flinders Petrie, and others are most precious. Nor are they less precious to him who studies art, or to the ethnologist who studies civilization, or to the naturalist who is interested in the distribution of the various types of mankind, or to the technologist who looks to the evolution of handicrafts. The public mind is beginning to realize the value of well-organized museums for purposes of special research as well as of general culture, and thus they appeal to the interest of the many, while books and a taste for books interest a narrower circle. To contemplate in the British Museum the frieze of the Pantheon is of itself an education in Greek art and in Greek ideas of beauty, and the most unlettered visitor to the Natural History Galleries cannot fail to carry away new ideas about the realm of nature. It is obvious, therefore, that in museums we have an instrument of great educational value, if they be organized to meet the increasing demands of modern investigation.

The Classification of the Museums of To-day.

The museums of to-day fall naturally into four groups. (1) The Art Museum, which includes also antiquities arranged from the art point of view. (2) The Natural History, which illustrates the history of nature in its widest sense, and of man in his physical aspects. (3) The Archæological and Ethnological, which deals with the works of man and his progress in civilization. (4) The Technical, in which objects are arranged in relation to industry. The leading idea of the first is art, of the second nature, of the third civilization, and of the last the conquest of mind over matter.

The Principles of Museum Organization.

These four groups are sharply defined from each other. In practice however it is often necessary to use for the illustration of one what, strictly speaking, belongs to the others. In all such cases, however, the reason of the presence of the alien object must be made obvious, if the general effect of the arrangement is to be preserved. For example, in the Manchester Museum, I found it necessary to complete the history of the Tertiary Period to illustrate the first appearance of man, and to carry on the narrative through the prehistoric and historic divisions down to modern times by a small selected series of specimens, showing the progress of mankind. Were it not for this they would be wholly out of place in a collection of natural history. In like manner our Egyptian mummy has its due place in the National Gallery in Trafalgar Square, its *locus standi* consisting in the fact that it illustrates the art of portrait painting among the Alexandrine Greeks of the first century after Christ.

Next in the point of importance to the leading ideas in museum work comes the question of labelling and illustration. The labels should be clear and distinct, and if possible in English as well as in Latin. The specimens should illustrate the labels quite as much as the labels the specimens. All possible means of illustration should be employed, maps, diagrams, restorations, and the like, so that the main points and relations are clearly brought home to the visitor. In addition to the systematic catalogue of each specimen there should also be a popular guide similar to those of the British Museum. It goes without saying that a collection of books is also necessary.

The kind of museum most desirable in any place depends entirely on the local conditions, and there is no hard and fast scheme applicable to all cases. Nor is the question of great or small to be looked at otherwise than as one of detail. A small well-arranged collection in a school or in a village will do the work which it is intended to do as well as large museums in the metropolis, or in a university, or in a centre of commerce. The principles of success are the same in all: they must be orderly, they must be intelligible, they must as far as possible appeal to the sense of beauty. Under no circumstances must unnamed and unknown specimens be allowed to appear. A ragged recruit may be drilled into a good soldier, but he spoils the parade if he appears out of uniform in the ranks. Nearly all of us who have had to do with museums have sinned in this matter, and it is not for me to cast a stone at my fellow sinners.

The work, however, is only partially done when a museum is properly arranged, labelled, and catalogued on the above lines. To make it intelligible in the best possible way, it is necessary that there should be lectures and demonstrations given in the museum itself, in which some special points should be taken up which interest either the general public or the special worker. In my experience oral instruction with the things before the eyes in the museum, and not away from it in the lecture-room, is the best manner of doing this. As an example of this, I would refer to the demonstrations organized in the British Museum by Prof. Stewart Poole, in which ancient art and civilization were dealt with, and to those which have from time to time been given in the national collection of natural history, under the auspices of Dr. Flower. In this relation the British Museum will be found to be one of the most valuable instruments for spreading knowledge in the University which London will have in the future. In this relation, too, the Geological Museum in Jermyn Street, around which are centred some of the ablest men of the time — De-la-Beche, Murchison, Ramsey, Edward Forbes, Tyndal, Huxley, and many others—has done most valuable service. It is in this direction that museums will influence the general education in this country, and take their natural place in the new learning.

Application of these Principles to the Manchester Museum.

I pass now to the application of the above principles to the Manchester Museum, Owens College. Our experience gained in bringing the old collection into harmony with modern requirements cannot fail to interest those who are now engaged in like work, because it may show not only what is to be copied, but what is to be avoided.

When the task of organization was entrusted to me in 1869, there was a large general collection of natural history, and a large geological collection. The former had been a first-class collection in the second quarter of this century, but had ceased to grow, and therefore had become dead. The second was in good order, and, under the care of its founders, Binny, Ormerod, and others, was properly named. Both, however, were in a most deplorable state so far as relates to fittings, and were simply ignored by the general public, and scarcely used by students. The first step was to sweep out of the way the miscellaneous objects which had no place in a Natural History Museum. The next was to organise what remained into a systematic collection in rooms and cases which were unfit for the purpose. Then followed evening lectures and demonstrations in the old Museum building in Peter Street. Later the teaching collections in Owens College were added, and the Museum began to revive and grow, slowly but steadily, as the connection with the College grew closer, till, in 1874, it was transferred to temporary quarters in the attics and basement of the Owens College. It continued to grow in spite of the removal and of the inadequate cases, and the interest of the public was maintained very largely by the system of Saturday afternoon demonstrations in the only part open to the public—the Geological Museum.

The systematic rearrangement in view of the new buildings was taken in hand. The minerals were arranged, labelled, and catalogued, Dana's "Hand-book of Mineralogy" offering a ready-made catalogue. To meet the mining interests of Manchester special groups of the minerals found in association were organized to illustrate the minerals of Derbyshire, the Lake District, Cheshire, the diamond mines, the apatite mines, and the like.

For the special ends of the geological teaching, the rock specimens were also arranged, and special groups were formed to illustrate their association—such as the products of Vesuvius, and of the volcanoes of Auvergne—and to illustrate the destruction of rocks by natural causes. Then naturally followed the classification of the fossils to show the sequence of events in the geological record. In this the Carboniferous flora and fauna naturally took a prominent place, because of the vast importance of the coal-fields to this district. The arrival, too, of the existing higher Mammalia, including man, on the earth, took a prominent place in the Tertiary collections, and formed the leading idea in the Tertiary chapter of a history of the earth, while the story of the earth was fitly closed by a series of groups illustrating the evolution of human culture and the prehistoric and historic periods. The general principle of classification throughout the whole geological series, or, in other words, the historical method, was that of *time*. Next the zoological collections were arranged, as far as the changing classification would allow, zoologically, with a special group for the zoology of Great Britain. The botanical collections, which offered exceptional difficulty, are now in hand. In this manner the whole of the collections were arranged for the time when they should find their place in the new buildings, and pass under the care of the professor in each department. A scheme of uniformity was carried out with regard to fittings and mounts also; a definite unit of size, 4″ × 1½″, was decided upon, and all tablets and glass boxes were made either on that or on multiples of that. This unit also ruled the size both of the drawers and of the cases in the new fittings. The system of printed labels in which black ink represents the specific name and the red the name of the group was also devised. In the plans of the new Museum the maximum amount of light, consistent with stability and architectural beauty, was the leading idea, while the laboratories and lecture-room of the whole of the Natural History Department of the College were brought as close as they could be to the Museum. The building itself was designed to suit the organization of the collections. Thus step by step the present Museum was gradually built up, and when the buildings were completed in 1884 the collections were transferred to the quarters which they now occupy, and where they form a centre towards which other collections gravitate.

While the museum has been rapidly growing during the last eight years, the system of museum lectures and addresses to various organizations, mechanics' institutes, schools, and the like has been largely developed. In its present state it is used largely by students of Owens College, and is growing in favour with the general public. In other words it is taking the place it ought to have in the education of this densely populated district. These results, it must be observed, have only been possible through the liberality with which the Museum has been treated both by the public and by Owens College. I look forward with confidence to the time when both will be amply repaid by the impulse it is giving, and will give, to the new learning.

I do not for one moment suppose that a natural history museum of this kind is suitable for all places. The *genius loci* must be, in all places, the genius of the museum. The principles however of success are the same in all, and success can only be achieved in a limited degree if there be no signs of the worship of some of the Muses in the arrangements.

The Work of the Museums Association.

In ending this address, all too long, I fear, for my audience, all too short for my subject, I must add a few words as to our work as a Museum Association. It is twofold. First, we must arouse ourselves to the present situation and note the directions which the intellectual movement of the day is taking. Next, it is our duty to arouse the public to the importance of museum development, and to take care that the claims of museums as instruments of education shall not be ignored in the grants made by public bodies for the good of the commonweal.

ON THE CARBURIZATION OF IRON.

I.

THE conditions under which carbon combines with iron have been closely studied, and the observed phenomena fully discussed. Even now, however, it is doubtful whether true chemical combinations of carbon and iron are formed. It has been alternatively assumed that carbon is with difficulty soluble in iron, and that at low temperatures solution may proceed very slowly. In other words, carbon is not easily dissolved except at high temperatures; and it follows that if highly heated iron fully charged with carbon be cooled, a portion of the carbon must be precipitated in this state, existing simply as foreign matter in the metal, but that, on reheating, it may again enter into solution. Low carbon steels may be regarded as dilute solutions of carbon in iron; pig or cast iron as saturated; and intermediate grades may be termed moderately concentrated solutions.

Against this, however, there is a mass of evidence which deserves attention and cannot be ignored. Percy states that for the full carburization of iron a high temperature is necessary, and further, considering the absolute infusibility of carbon, it seems reasonable to assume that these elements must enter into chemical combination. It is, however, admitted that this compound may have the power of dissolving additional carbon; this explains the copious deposition of carbon in the graphitic form when iron is cooled. Dr. Percy finally concludes that there must be at least one definite compound of carbon and iron, but adds that there seems to be no reason why solution should not occur, as in the case of mercury, which liquefies gold, silver, or copper.

Prof. Roberts Austen also ("On Certain Properties common to Fluids and Metals," Royal Institution, March 26, 1886) speaks of the power which certain solid metals have of even rapidly taking up fluids—clearly cases of solution. Abel claims to have proved the existence of a definite compound of carbon and iron. Prof. Roberts Austen also finds that heated iron combines with pure carbon in the form of diamond dust. The author also has succeeded in directly combining iron fused *in vacuo* with pure sugar charcoal presumably freed from gases by repeated heatings *in vacuo*. Yet it is obvious these instances may all be explained on the theory of solution at elevated temperatures, with the exception of Prof. Abel's, who claims to have isolated a definite carbide of iron from the metal.

Matthieson, as the result of an elaborate research, states that "with few exceptions" most of the known two-metal alloys are solidified solutions of one metal in another. Carbon-iron alloys may be looked upon as solidified solutions of carbon in iron, and the analogy of cast iron with other alloys indicates the non-existence of chemical combination between carbon and iron.

Again, viewing alloys as definite chemical combinations, the facility with which heated iron absorbs certain gases does not admit of easy explanation.

Deville, however, imagines a kind of porosity in the metals, terming it an intermolecular porosity, sufficient to admit of the passage of gas at a low temperature; and supposes it developed by the expansive agency of heat. Graham assumes that the affinity of the gases for iron and platinum is as the attraction admitted to exist between a soluble body and its solvent.

Other metallurgists are of opinion that carbon does not directly combine with iron, attributing their union to the direct action of carbon monoxide gas always present in iron; by the agency of this gas carbon is indirectly transferred to iron; but it would appear that this cannot be maintained, for it has been proved that carbon combines directly with iron one way or the other, *i.e.* by solution or chemical combination.

Whatever may be said of irons containing an excess of carbon, *i.e.* cast iron and very hard steel—which, if one grants that carbon is not very soluble in iron at a low temperature may be termed supersaturated solutions—in the case of low carbon steels there seems some ground for assuming that carbon is merely dissolved in the metal.

Sir L. Bell tells us that, on heating thin sheets of carburized metal or steel piled closely together, the excess of carbon contained in one or more of the sheets is transferred to the others. Wrought iron is carburized in much the same manner by the cementation process, and it is equally possible that heterogeneous iron, *i.e.* iron containing intermixed carbon or graphite, and as a rule not equally diffused, may by continued sufficient heating become practically homogeneous.

It is a well-known fact that the carbon in low carbon steel —for instance, Bessemer steel—exists in at least two different forms; Prof. Ledebur says four. Akerman (Iron and Steel Institute) classifies these as (1) hardening carbon, or the carbon which determines the quality of steel, (2) cement carbon, and also graphite may be present.

The united researches of many workers in this field of research indicate generally that a portion of the total carbon is in intimate union with the metal, and that the more intimately combined or hardening carbon determines the quality of the steel. The carbon incompletely combined (or intermixed carbon) is termed cement carbon, because it occurs in the largest proportion in blister or cement steel.

Does not the above point to a case of solution of carbon, in which the quantity in solution is determined by temperature, just as with other solutions?

Metallurgists, however, can hardly accept the theory of solution without qualification.

Mr. Spencer states that "unhardened steel containing 1·18 per cent. total carbon—of which the colour test indicated ·89 per cent. as combined carbon, and residual carbon or graphite ·29 per cent.—after being hardened, gave only ·58 by colour test, and only traces of graphitic carbon, showing a loss of ·51 per cent. of carbon. A softer steel, containing ·50 total carbon—equalling ·45 per cent. by colour test, ·04 per cent. graphitic carbon—after hardening, only ·21 colour test carbon; graphitic carbon ·00, showing a loss of ·29 per cent. Other analyses were made confirming the above, and establishing the fact that after hardening there is always a proportion of carbon which can neither be determined as graphite or by the colour test, and this proportion is found to increase according to the larger amount of carbon in the metal, and the rapidity with which it was cooled" (Mr. Spencer, Iron and Steel Institute).

The facts above quoted are not apparently in accord with the theory of solution; but there are undoubted allotropic modifications of carbon, and this peculiar form may be one of these, "uncombined," and may be classified with the graphite, or really as merely intermixed foreign matter.

There is the alternative assumption that the missing carbon may exist in some form or combination with the iron, possibly not capable of being registered by the colour test; but as the steel is treated with dilute nitric acid, in which it is completely soluble, with the exception of the graphite, this assumption can hardly be maintained.

Referring to Akerman's assertion that only combined "hardening" carbon determines the physical properties of steel—an assertion with which Mr. Spencer agrees—"The apparent loss of carbon shown by the latter, and which we have determined as intermixed carbon or a form of graphite"—it may well be that the missing carbon is so intimately mixed as to be in a state closely bordering on solution, for it is well known that it is difficult to draw the line between absolute solution and matter finely suspended in a liquid. The latter practically often presents the appearance of a solution scarcely to be distinguished from it. Messrs. Harold Picton and L. E. Linder (Chem. Soc., January 1891) are of opinion that there is a continuous series of grades of solution passing without break from suspension to a crystallizable solution. This seems very probable, and in accordance with our chemical experience.

Graphite, if the author has adequately grasped Prof. Akerman's views, has little or nothing to do with the quality of iron. "Graphite carbon exerts an influence only on iron in so far as it diminishes the continuity of the iron molecules. We often meet with the incorrect statement that the influence of carbon on pig-iron is quite different from its action on steel and malleable iron.

"It is easy to prove to the contrary if we distinguish properly in pig-iron between the combined carbon and that which is only mechanically incorporated as graphite, which ought not to be included in the calculation if we wish to form a judgment on the properties of pig-iron as dependent on its contents of carbon."

As one understands this, the same applies to steel.

So far there can be no difficulty in assuming at least the probability of the solution of carbon in iron, and that the physical qualities of the metal are determined by the quantity of carbon in solution, *i.e.* Akerman's hardening carbon.

The facts, *per contra*, appear mainly to indicate that carbon is merely sparingly soluble in iron at temperatures below its fusion-point.

A more serious objection (previously referred to) is that carbon is practically infusible, more especially in the graphitic form. How this intractable body so readily interpenetrates iron is a problem not easily solved.

The ordinary chemical theory of solution as usually understood does not, however, seem applicable on the whole; but some of the results accruing from the recent development of the gaseous, or rather physical theory of solution, may be made available for this purpose.

The Physical or Gaseous Theory of Solution.

In cases of simple solution the dissolved substance may be regarded as being evenly distributed throughout the solvent. The substance is dissolved by virtue of osmotic pressure, and Van 't Hoff has shown that osmotic pressure in solutions corresponds to gaseous pressure in space.

Further, it appears that both Boyle's and Charles's law holds good, at least for dilute solutions, osmotic being the equivalent for gaseous pressure, which pressure increases for constant volume proportionally to the absolute temperature. It has been, however, objected that Boyle's law is not strictly applicable to "more especially concentrated solutions," but Prof. Orme Masson (NATURE, February 1891), states that these are comparable with the case of gases at high pressures. Again, exceptions are claimed under the law of Avogadro, *i.e.* equal volumes of gases contain equal numbers of molecules under like conditions of temperature and pressure, but as regards compound gases exceptions occur, as also with dilute solutions.

Exceptions can be explained by the theory of dissociation. The analogy between gases and the physical theory of solutions thus seems complete, and Ostwald describes an experiment indicating the existence of free ions in a dilute solution of potassium chloride; other instances might also be quoted.

The author's object, however, is not to discuss the absolute correctness or otherwise of the theory of gaseous solution, which seems pretty well established; but to show that it may be applicable to the solution of carbon in molten, semi-fluid, or even merely heated iron, apart from possible cases of dissociation and chemical combinations. Solution is simply the even distribution of one body in another, or such distribution as that of permanent gaseous matter through space. It may be urged that the theory is not applicable to semi-fluid or merely heated iron. No definite line can, however, be drawn; it is obvious that the different grades of temperature are simply approximations, more or less, to the ideal fluid condition. The law of solution, as above defined, may suffer modifications, but need not in consequence be rejected.

"*Definition of Osmotic Pressure.*[1]

"Osmotic pressure is really a definite force. With suitable apparatus this force can be measured, in centimetres of a mercury column, and Pfeffer has shown that this, the osmotic pressure, is intimately connected with the nature of the dissolved substance.

"The pressure was found to be dependent on, and in proportion to, the concentration of the solution; the pressure at a specified concentration is dependent on the temperature—a rise in temperature corresponds to an increase in pressure.

"This discovery remained unnoticed. In the first instance the facts were only required for the elucidation of certain physiological questions.

"And it was not until 1886 that Van 't Hoff developed a theory of solution based on these phenomena.

"Osmotic pressure is a specific property of the substance in solution, and in this respect resembles gaseous pressure. The analogy between the state of solution and the gaseous state is clearly shown (pp. 115–17). Dissolved substances exert the same pressure in the form of osmotic pressure as they would exert if they were gasified at the same temperature without change of volume.

"All that we know of gases holds good for solutions, substituting osmotic for gaseous pressure.

"Osmotic pressure is, in some instances, very great."

And it seems clear that osmotic pressure is not a mythical, but a real or actual force of considerable power, and one which may be rationally applied to the elucidation of the cause of the carbonization of iron; further, it may even afford a clue to the phenomena observed in the production of other alloys.

As regards the carburization of iron, the physical theory of solution, "founded on the identity of osmotic with gaseous pressure," seems the only one capable of affording a satisfactory explanation of the facility with which carbon combines with iron.

The chemical, or old, theory of solution apparently fails to do this. The same may be said of the assumption that chemical combinations of iron and carbon are formed. Although it must be granted such combinations may exist, yet, in the author's opinion, complete proof is still wanting. It is really difficult to realize, when dealing with stable bodies like iron and carbon, how their union can be thus accomplished.

On the contrary, the application of the law of osmose renders the conception of the transfer of carbon to iron very easy. This force, exerting probably almost illimitable power in nature, seems the only one capable of overcoming the *inertia* of bodies; such, for instance, as that of iron and carbon.

The physical theory of solution has hitherto only presumptively herein been applied to the solution of solids in liquids; and it may be asked, Is it applicable to the case of the solution of solids in solids, such as carbon and iron, when heated?

To this one can reply with confidence that the absolute solid has no existence. Unless we reject the atomic theory, it is evident that no tangible mass of matter can be termed a solid: it is an agglomeration of atoms. Further, accepting the definition of what is termed the atomic volume—*i.e.* the space occupied or kept free from the access of other matter, by the material atom itself, together with its investing sphere of heat—it follows that the atoms must be apart from each other in the so-called solid mass, and the distances between the atoms are probably considerable as compared with the actual volume or size of the atoms themselves. Therefore, there can be no difficulty in conceiving that osmotic pressure plays a part in the case of a mass of matter, "conventionally termed a solid." It is only a question of degree; the quantity of matter dissolved in a given time is simply a function of the temperature applied, and at a low temperature, the effective osmotic pressure in the case of solids seems comparable to that of a liquid evaporating under pressure of its own vapour. Evaporation is retarded, and the analogy may hold good in the case of the conventional solid.

JOHN PARRY.

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[1] Ostwald, "On Solution."

PHOTOMETRIC OBSERVATIONS OF THE SUN AND SKY.[1]

ATTEMPTS have been made by Clausius and various other mathematicians to calculate the light at different points of the perfectly clear sky, and to compare the light of the whole (or a portion) of the sky with that of the sun. The difficulties of photometric measurement have prevented any of the theories being thoroughly established by experimental verifications.

In the first period of photography, it became a matter of practical importance to have some way of testing roughly the "actinic activity of diffused daylight," in order to obtain a guide for the time of exposure. Very many photographers, in those days when the evils of over-exposure could not be corrected in the printing, must have exposed a scrap of sensitive paper, and thence concluded how many seconds' exposure they would allow.

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[1] "Photometric Observations of the Sun and Sky," by Wm. Brennand. Proceedings of the Royal Society, vol. 49, n. 288, April 18, 1891, pp. 255–280.

From this point it would be a very easy step to test the "actinometric effect on sensitized paper" ("chemical action" of Roscoe) of different skies, or of the sun at different altitudes. It is not probable that the chemical action is simply proportional to the light; but it would be soon found that the "chemical action" could be much more accurately measured than the light.

Sir Henry Roscoe (partly in junction with Bunsen and with Thorpe) made many investigations and various publications between 1859-70 on the chemical action of the sun and sky as measured by its effect in darkening photographically sensitized paper. Roscoe delivered the Bakerian Lecture in 1865, "On a Method of Meteorological Registration of the Chemical Action of Total Daylight."

Throughout his investigations Roscoe pursued a direct method of experiment: he elaborately investigated a method for obtaining always paper of standard sensibility; he devised a plan for obtaining a light of standard intensity; he then exposed a piece of the paper to the action of the sky, or of sun and sky, or of a portion of the sky, and compared the effect produced in a given number of seconds with that produced in the same paper in the same number of seconds by his standard light. Roscoe also, by a laborious method, verified his fundamental asumption that light of intensity 50 acting for 1 second has the same effect as light of intensity 1 acting for 50 seconds.

Roscoe took half-hourly readings at Manchester, and thence gave the (comparative) actinic effects of the sky at different seasons of the year. Also he compared the chemical intensity of total daylight at Kew and Para, and investigated the relation between the sun's altitude and the chemical intensity of total daylight in a cloudless sky. By total daylight Roscoe meant the chemical action produced by the sun and whole sky together on a piece of paper exposed horizontally.

Roscoe found that his readings were enormously affected by the cloud-haze or invisible vapour in the air in England; he got his results, as to comparison of the chemical intensity at different seasons of the year, and at different altitudes of the sun, by assuming that in the average of a large number of observations, the effects of cloud, &c., would be self-destructive.

Roscoe found that the "chemical effect" of the sun depended only on his altitude (in a cloudless sky), being the same at Para and at Kew. He got very anomalous results as to the effects in spring and autumn in England, probably because the effects of cloudiness were not self-destructive in his series of observations. He arrived, by "averaging" the cloud irregularities, at the law that "the relation between the sun's altitude and the chemical intensity of total daylight is graphically represented by a right line" (a result only a rough first approximation to the truth). Roscoe obtained small result in comparing the chemical action at different points of the same sky, partly because he could make no experiments in person on a tropical clear sky, partly because to note these differences requires superior instruments to the direct experiment method alone tried by Roscoe.

Mr. W. Brennand was engaged at Dacca in observations, parallel to those of Roscoe, and nearly contemporaneous, 1861-66. Brennand was quite unaware of Roscoe's experiments. Being an amateur photographer, and his own photographic chemist, he was first led to devise an instrument for testing the chemical action of sun and sky, in order to obtain guidance for the number of seconds to expose a photographic plate. He was soon led on to investigate the effect of the sun at different altitudes, the effect of the sky for different altitudes of the sun, and finally the law of distribution of the "chemical action" in a perfectly cloudless sky.

Brennand's procedure in experiment differed fundamentally rom Roscoe's in two points:—

(1) Brennand only attempted observation in the cold weather at Dacca when he had a complete horizon of clear sky. He was thus enabled to carry his investigations into the laws of chemical action in a cloudless sky much farther than Roscoe, 90 per cent. (at least) of whose observations were obscured by cloud irregularities that could not be allowed for.

(2) Instead of Roscoe's direct method of observation, Brennand was early led to devise an instrument (the water-motion actinometer (see NATURE, January 8, 1891, p. 237), by the aid of which he was independent both of the standard light and standard paper attained by Roscoe with so great labour. The sun himself was, in fact, Brennand's standard light, and the darkening of each paper was read as a ratio; for instance, if an exposure of 10 seconds to sun and sky produced the same tint in the paper that was produced by the sun alone in 17 seconds, then the effect of the sun alone was reckoned $\frac{10}{17}$ of the sun and sky together. It is clear that *any* uniform paper should give such ratios the same, though the actual shades produced would be different in different papers. All the papers made by Brennand himself were found "uniform," *i.e.* to within the limits of variation (say, 2 per cent.) within which the darkened paper can be read, *i.e.* the shades can be matched. Any good photographic paper is found uniform enough for the purpose; but some of the ordinary photographic papers tried lately in England have been found not good enough; the nature of the irregularities introduced by imperfect paper is such as to suggest very soon their cause.

It is to be noticed that all that can be observed is a ratio: the observations in Roscoe's direct process are not absolute. In that process there is a standard unit, viz. the blackness produced in the standard paper by the standard light action at the unit of distance for n seconds. Any other light that produces this blackness has the numerical value $\frac{x}{n}$ in Roscoe's unit. There is little doubt but that Roscoe got his standard light and standard paper, each time he recovered them, correctly within the percentage of error involved in the reading. He would be certain to have prepared his salts of exactly the proper strength; but there is an element of uncertainty in the degree in which papers apparently of similar texture and in a similar state of dryness, &c., take up salts. This element of uncertainty is avoided by Brennand's method, which is far more absolute than Roscoe's.

The water-motion actinometer gave Brennand, for each observation, a shaded strip darkened gradually from 0 to 8 (or to 16) seconds. He could note on this the point at which a particular unit of darkening was produced, and the inverse of this time gave him a measure of the ratio of the observed "chemical action" to that which had produced the unit darkening.

This, of course, involved the assumption that light of intensity 50 acting for 1 second has the same effect as light of intensity 1 acting for 50 seconds. This Brennand thought might be assumed; but he proved it in the following very simple manner.

A slip of sensitized paper is formed into a ring (a short cylinder) and placed round a light (the wick of a candle was used, but any light would do, irregular or not) excentrically. After a certain time the slip is examined and found to be shaded gradually from the farthest to the nearest point, the effect at each point varying inversely as the square of the distance.

Thus if A be the source of light, O the centre of the ring, and if we have $OB = a$, $OA = b$, $POB = \theta$, we shall have the chemical effect at any point P of the slip vary as

$$\frac{1}{R^2} = \frac{1}{AP^2} = \frac{1}{a^2 + b^2 - 2ab\cos\theta}.$$

In a particular experiment Brennand took $a = 1\cdot4$ inch, $b = \cdot4$ inch.

$$\cos^2\frac{\theta}{2} = \frac{3\cdot24 - R^2}{2\cdot24}.$$

Taking the unit of intensity that at the distance 1 inch from the wick, and calculating the values of θ for values of the intensity 1, ·75, ·5, and ·3, we have $\theta = 0, 20^\circ\ 10', 78^\circ\ 34'$, and $141^\circ\ 48'$ respectively. The lengths of arc corresponding to these are found to be ·49 inch, 1·92 inch, and 3·45 inches respectively. These lengths can be marked off on the slip. Another slip can then be darkened in the water-motion actinometer, by any light; a unit can be marked on this slip at the point where the shade corresponds with that at the unit in the ring slip; it then can be seen whether the intensity of shade at the distance ·49 on the ring slip agrees with that at three-fourths the time for unit on the actinometer slip; and similarly for the other calculated values. This experiment verifies the law assumed, and moreover affords a check on the paper employed, and on the closeness with which tints can be matched.

Another important means of verification was employed by Brennand, which Roscoe does not appear to have availed himself of. Calling the effect of the sky alone in darkening paper B, and the effect of the sun and sky together A, Roscoe observed A and observed B, and then calculated the effect of the sun alone as A − B. Brennand did this; but also observed the sun alone by the simple device of a vertical slit in a shutter, and was thus able to check the accuracy of his method and of his work.

Having thus established the trustworthiness of his *modus* *operandi*, Brennand, with his water-motion actinometer, drew up, by an ample series of observations extended over several years, the Table B given in NATURE (January 8, 1891, p. 237). The numbers in this table are ratios, and they may be all multiplied by any number without any real alteration in the table. The unit of chemical action originally started with was the blackness produced by 100 grains of a candle burnt at the unit of distance; and this is the unit which underlies Table B. Brennand early found, as Roscoe found, that the sun has always the same effect at the same altitude in a perfectly clear sky. Hence, in all the later observations the unit was recovered from the sun.

Thus, to take a series of observations, with the water-motion actinometer, with strips of an unknown (but uniform) paper: first, a strip is placed in the instrument, the sun alone being admitted by the vertical slit, and the sliding shutter is run up; we thus get a gradually tinted slip beside the gauge marked in seconds. The altitude of the sun is noted; suppose it 30°; the number in Table B for this altitude is 0·1070, *i.e.* the number of seconds which produces unit darkening by sun alone at this altitude is $\frac{1}{0\cdot107}$ seconds $= 9\frac{1}{3}$ seconds. Then on the sun strip a mark is made opposite the $9\frac{1}{3}$ seconds graduation on the gauge; this is the unit blackness for the paper, and any subsequent strip exposed is "read" by marking the point on it which has the same blackness.

This method of recovering the unit is not sufficient to determine, for instance, whether the sky in England on a certain morning was really clear, *i.e.* as truly clear as the Dacca cold-weather sky. To determine this particular point, Brennand lately in England burnt 100 grains of a candle (as near as he could get) similar in composition to his Dacca candle, and the result shows conclusively, by the exact accord of several observations lately made near Taunton with corresponding old observations at Dacca, that in this case the two candles must have produced equal effects. But it is obvious that the candle could only be trusted by these results. The experiments made with the candle were not made to recover the Dacca unit, but to test the candle. The exact agreement in the several results raises the very strongest presumption that the Taunton candle was equal to the Dacca candle. It is, however, possible that the Taunton sky varied for the several observations in exact ratio with a variation in the Taunton candle; and it can only be said that Brennand's observations on this particular point, so far as they go, support Roscoe's result that the chemical action of the sun is the same at the same altitude in a perfectly clear sky, always and everywhere.

When the chemical action of the sky (or of some portion of it) on a piece of flat paper is observed, what is measured is the integral of the resolved effects of each sky element. Thus if, as in Roscoe's experiments, the piece of sensitized paper is exposed horizontally, and the effect of the whole sky (the sun being stopped off) is taken, we have the total effect of a ring of the sky distant θ from the zenith to be multiplied by cos θ, and then the effect of all such rings from the zenith to the horizon to be summed. This view of the resultant action suggested to Brennand the more original branch of his investigations. He was early led to suspect that the chemical action of the sky varied in different parts of it. He devised an instrument, which he calls the mitrailleuse actinometer, by which he was enabled to prove that the chemical action of the sky is a minimum in the great circle distant 90° from the sun; for an altitude α of the sun this minimum he calls i_α. Brennand then further proves that the chemical action (at the same time) at any other point of the sky distant θ from the sun is then i_α cosec θ.

Having established these important laws, Brennand is able, by mathematical process, having i_α given him, to calculate the total effect of any defined portion of the sky on a plane of sensitized paper exposed at any given angle. He was thus enabled to compare Roscoe's readings of total diffused daylight on paper exposed horizontally with his own Dacca readings on paper exposed perpendicularly to the direction of the sun.

These investigations led Brennand to a theoretic value for the duration of twilight, and to the devising a new instrument, the "octant actinometer," by which the fundamental constant i_α can be observed directly.

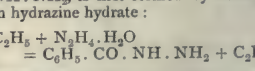
This "octant" actinometer observes one-eighth of the heavens, cut out by three planes at right angles to each other, placed so that the line OS, the intersection of two of the planes, passes through the sun. Owing to the cloudy skies of Taunton, Brennand (who experiments only with a clear sky) had been able very imperfectly to test this instrument at the time his paper was read to the Royal Society. He has since found that this "octant" may be turned in any way round OS (above the horizon, of course) without altering the reading on either of the three planes of the octant. This "octant," therefore, only requires one-fourth of the visible hemisphere round the zenith to be clear, for a good observation. What is more important, it enables the observer, when the sky is clear, and the sun's altitude from 30° to 60°, to take an observation of a part of the sky entirely 30° from the horizon; so that the uncertainty arising from haze near the horizon (which could not before be allowed for) may by this capital instrument be avoided, and i_α obtained without any integrations or calculations beyond division by a number.

In the whole of these later developments, Brennand's work is entirely original. Sir Henry Roscoe, following a somewhat different course of inquiry, has made experiments on the chemical action of the sun and sky at different levels above the sea; and on the total effect during different months or seasons of the English sky with all its cloud, fog, and smoke; which last is an important practical measure of the climate in its influence on vegetation, and perhaps on human health.

The researches of Roscoe and Brennand have thus, though overlapping at particular points, extended mainly in different directions. Brennand, in the ground covered by both, puts forward far the more accurate determinations; his table (B) given in NATURE, January 8, 1891, p. 237, professes to be of the same character and value as a table of the constants of refraction,—Brennand has had half a century's experience with the chemistry of photographic paper, and is an excellent mathematician of the old school. Moreover, the three leading actinometric instruments he has devised, the water-motion, the mitrailleuse, and the octant, show him to be possessed of much resource in devising instruments of research.

INORGANIC SYNTHESIS OF AZOIMIDE, N_3H.

A METHOD of synthesizing this interesting compound of nitrogen and hydrogen, by means of a simple reaction involving only purely inorganic substances, has been discovered by Prof. Wislicenus, and is described by him in a communication to the current number (No. 12) of the *Berichte* of the German Chemical Society. The reactions by which azoimide has hitherto been obtained have all been of an organic nature, and more or less complicated. The mode of preparation described by its original discoverer, Prof. Curtius, in reality depends upon a very simple reaction, that of nitrous acid upon hydrazine, N_2H_4, the other hydride of nitrogen whose preparation we also owe to Prof. Curtius,

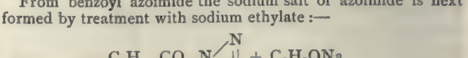


$$\begin{array}{l}NH_2\\ \mid\\ NH_2\end{array} + HNO_2 = N_3H + 2H_2O.$$

Hydrazine, however, has only yet been prepared from its organic derivatives, and moreover it has not been found practicable to actually convert free hydrazine itself by means of nitrous acid into azoimide, only certain organic derivatives being acted upon by nitrous acid with production of azoimide. The perfected mode of preparation described by Prof. Curtius at the close of last year is very briefly as follows. Benzoyl hydrazine, $C_6H_5 . CO . NH . NH_2$, is first formed by reacting with ethyl benzoate upon hydrazine hydrate:

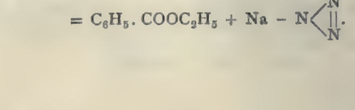
$$C_6H_5 . COOC_2H_5 + N_2H_4 . H_2O$$
$$= C_6H_5 . CO . NH . NH_2 + C_2H_5OH + H_2O.$$

The benzoyl hydrazine is then converted by means of nitrous acid, obtained from a mixture of glacial acetic acid and sodium nitrite, into the benzoyl derivative of azoimide:



$$C_6H_5 . CO . NH . NH_2 + HNO_2 = C_6H_5 . CO . N\Big\langle\begin{array}{c}N\\ \|\\ N\end{array} + 2H_2O.$$

From benzoyl azoimide the sodium salt of azoimide is next formed by treatment with sodium ethylate:—



$$C_6H_5 . CO . N\Big\langle\begin{array}{c}N\\ \|\\ N\end{array} + C_2H_5ONa$$
$$= C_6H_5 . COOC_2H_5 + Na - N\Big\langle\begin{array}{c}N\\ \|\\ N\end{array}.$$

Free azoimide is finally obtained by distilling the crystals of the sodium salt with dilute sulphuric acid, and repeatedly re-distilling over fused calcium chloride the hydrated liquid which first passes over.

As an alternative method which has some advantages as regards facility of manipulation, Prof. Curtius employs the hippuryl derivative of hydrazine instead of the benzoyl compound The product of the action of nitrous acid upon this compound is a substance which can be readily isolated in crystals, and if these crystals are dissolved in dilute caustic soda, the solution at once yields azoimide upon distillation with dilute sulphuric acid.

Before describing the inorganic synthesis of Prof. Wislicenus, it may be mentioned that a still simpler organic synthesis of azoimide from the long known diazobenzene imide, $C_6H_5N_3$, has been achieved by Drs. Noelting and Grandmougin. Although diazobenzene imide itself is too stable a substance to yield azoimide directly by simple saponification with soda, these chemists found that its dinitro derivative yielded directly to the attack of an alcoholic solution of potash, the potassium salt of azoimide being formed, which of course gave free azoimide upon distillation with dilute sulphuric acid.

The inorganic synthesis of azoimide now achieved by Prof. Wislicenus depends upon the interaction of ammonia gas and nitrous oxide in the presence of heated metallic sodium. Ammonia and nitrous oxide do not act directly upon each other, not even when a mixture of the two gases is passed over caustic bases—soda-lime for instance. But they react readily in presence of metallic sodium. The explanation of this lies in the fact that the sodium amide discovered by Gay Lussac and Thenard is first formed, and this compound reacts with the nitrous oxide with production of the sodium salt of azoimide:—

$$NaNH_2 + N_2O = NaN_3 + H_2O.$$

The water produced at the same time reacts with one-half of the sodamide, forming caustic soda and liberating ammonia gas:—

$$NaNH_2 + H_2O = NaOH + NH_3.$$

Hence the complete reaction may be expressed by the equation—

$$2NaNH_2 + N_2O = NaN_3 + NaOH + NH_3.$$

As the sodium salt is less explosive than most of the other salts of azoimide, requiring a higher temperature and not being sensitive to percussion, the experiment is not dangerous if proper care is exercised, and even if local explosions do occur they have not yet been observed to shatter the glass tube. Unfortunately glass is somewhat strongly attacked during the reaction, but if iron tubes are employed the reaction is not so completely under control.

In actually conducting the experiment, metallic sodium, in pieces not exceeding half a gram in weight, is placed in a series of large porcelain boats, which are then laid in a glass combustion tube, from which the air is subsequently displaced by means of a current of ammonia gas. The tube is heated carefully in a combustion furnace, when the sodium fuses and gradually passes into sodamide. When all the metal has been thus changed, the stream of ammonia is replaced by one of dry nitrous oxide. The temperature should now be lowered to between 150° and 250°, and for this purpose Prof. Wislicenus surrounds it by an iron explosion chamber, which forms a capital air-bath, the temperature of which can be regulated by observing a thermometer or thermometers inserted in it. The sodamide now slowly increases in bulk and becomes converted into the sodium salt of azoimide. As soon as ammonia ceases to be carried away in the stream of issuing nitrous oxide the reaction is completed. Upon cooling the sodium salt is found as a porous pumice-like substance, much distended by the escaping ammonia.

The sodium salt of azoimide is also formed when ammonia and nitrous oxide gases are simultaneously passed over melted sodium; the yield, however, is not so large, and there is danger of the sodium inflaming in the nitrous oxide.

The fact that the sodium compound obtained is the sodium salt of azoimide has been proved both by direct analysis (a determination of nitrogen yielding close upon the theoretical amount) and by its properties. The product of the reaction on being removed from the combustion tube was thrown into water, and the filtered solution distilled with dilute sulphuric acid. The distillate possessed the intolerable odour characteristic of azoimide, and behaved exactly like a solution of that substance in water. It gave precipitates with nitrates of silver, mercurous mercury and lead, which when separated and dried were found to possess all the properties of the silver, mercury, and lead salts of azoimide respectively. The fact that these salts were those of azoimide was indeed sufficiently apparent from their violently explosive nature, and the characteristic flames which were produced during their explosion. Moreover, gold dust was rapidly dissolved with production of the red solution described by Prof. Curtius.

A quantity of the silver salt was subjected to analysis, and was found to contain 71·7 per cent. of silver, the amount calculated for AgN_3, being 71·8.

Instead of sodium, either potassium or zinc may be employed. Potassium answers almost as well as sodium, forming first an amide when heated in a current of ammonia, which is subsequently converted by nitrous oxide into the potassium salt of azoimide. Zinc likewise behaves in a similar manner, but the yield of the zinc salt of azoimide, ZnN_6, is not so good as in the cases of sodium and potassium. To a greater or less extent, therefore, it would appear that metallic amides when heated in a current of nitrous oxide are generally converted into salts of azoimide. The alkali metals, however, appear to be best suited for practical use.

A. E. TUTTON.

THE REPORTED VOLCANIC ERUPTION AT GREAT SANGIR.

ACCORDING to a Reuter's telegram from Sydney, despatched on July 17, the vessel *Catterthun*, belonging to the Eastern and Australasian Steamship Company, which had arrived at Sydney from China, brought a report of a terrible disaster in the vicinity of the Philippine Islands. She called on her voyage at one of the chief ports of the island of Timor, where rumours had been received according to which the island of Sangir, situated between Celebes and Mindanao, had been destroyed by a volcanic eruption. The whole population, numbering 12,000, was reported to have perished. The captain of the *Catterthun* stated that on the voyage his vessel passed through some miles of volcanic *débris*.

We may not for some time receive further details as to the real extent of the disaster reported by the captain of the *Catterthun*, but in the meantime the following account, by Mr. Sydney J. Hickson, author of "A Naturalist in North Celebes," of the island and of the history of its volcanic energy—which appeared in the *Times* of Tuesday—will be read with interest:—

> Sangir, or "Great Sangir," as it is more frequently called by the natives of the Archipelago, is the largest of a chain of volcanic islands that connects the northern peninsula of Celebes with the southern point of the island of Mindanao. The islands, rising abruptly from the floor of the very deep Celebes sea—a depth of over 2,000 fathoms was found by Her Majesty's ship *Challenger* quite close to Great Sangir—are very mountainous and covered by dense tropical forests.
>
> The islands Ruang and Siauw are both little more than volcanoes standing in the sea, but Sangir is a large island 25 miles long by about 15 miles broad, with undulating hills and valleys occupying its southern half, and the great Awu volcano and its slopes the greater part of its northern half.
>
> When I visited the islands in November, 1885, the Ruang and the Awu were quiet, but the Siauw was sending out dense volumes of smoke that varied little in intensity from day to day.
>
> From the accounts I received from the natives and from the records of the islands in the Dutch books of travel, it seems that the Siauw volcano has never been very violently active, but both the Ruang and the Awu have a history full of most terrible and heart-rending episodes. Of the Ruang I need not say much. The last serious eruption occurred in 1871, when at least 400 persons lost their lives either by the sudden rise of the sea water that accompanied the eruption, or by the showers of stones and ash. Of the Awu volcano we find recorded in Valentijn's "Oud en Nieuw Oost Indien" that a most terrible eruption occurred which lasted from the 10th to the 16th of December, 1711. Sjamsialam and his son, the Princess Lorolabo and her daughter Sarabanong, and over 2000 people of the kingdom of Kandahar were killed. On March 2, 1856, there was another fearful eruption, which lasted until March 17, and destroyed nearly 3000 human lives. The streams of boiling water and of steam which poured down the mountain slopes rather than the flow of lava caused the enormous mortality of this second eruption. After the eruption of 1711 it seems that a large lake of water was formed in the crater, and a certain privileged class of Sangirese were allowed by the gods to visit this lake every three or four months to test the water with their rice. If

the water was hot enough to cook their rice they took it for a sign that an eruption would shortly follow. The great eruption came in 1856. The waters of the lake began to boil, burst their banks, and flowed down the sides of the mountain towards Tabukan and Taruna, causing immense destruction of human lives and property.

Concerning the present eruption we learn very little at present, but it seems to me very improbable that the whole island has been destroyed, and, from the sparseness of the population on the slopes of the Awu, it is also very improbable that so many as 12,000 persons have lost their lives.

The population consists of one Dutch Controlleur, who may possibly be married, some three or four German missionaries with their wives and children, one or two European traders, a few Chinamen, and the remainder Sangirese Malays. The island is governed by five native Rajahs, who are advised by the resident Dutch Controlleur. For many years there has been no war or other disturbance, but the island, notwithstanding the richness of its soil, is not in a very prosperous condition. The only produce of any importance is copra, but some good ebony and other timber is found in the forests that cover the islands.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 11.—M. d'Abbadie in the chair.—On a slight additive correction which may have to be applied to the heights of water indicated by sea-gauges when the swelling or choppy agitation of the sea attains a great intensity; case of a swell, by M. J. Boussinesq. From theoretical considerations and practical experiments it appears that a tide-gauge exposed in a lateral basin will not give correct indications of level for a choppy sea, but that it will register a lower level than it would if the water were at rest. For a wave 1 metre high the difference may amount to 1 cm.—On the determination of the density of gases, by MM. Henri Moissan and Henri Gautier. This is achieved by a new method, which makes it possible to determine the density within one or even one-half per cent. from a volume of 100 cc. of the gas. The principle is analogous to that adopted by Dumas in his researches on vapour-densities, and consists in measuring the difference between the weight of a known volume of the gas and an equal volume of air at the same temperature and pressure. If this difference in grammes be denoted by p, and if v denote the volume of the gas or air at temperature t° and pressure H, the density is given by the equation

$$p = v \times 0{\cdot}001293\,(x-1) \times \frac{H}{760} \times \frac{1}{1+0{\cdot}00367t}.$$

The apparatus consists of a glass cylinder of about 90 cc. capacity connected at its lower end with a glass tube leading through an india-rubber tube to a movable flask filled with mercury, by means of which the pressure inside the measuring cylinder can be regulated. The latter is surmounted at its upper end by a weighing bulb separated by a three-way cock, by which communication can be established with a fine bent tube. In the experiment, the bulb is first exhausted, then filled with dry air and again exhausted, this being repeated about ten times. It is then shut off, and the fine tube and the measuring cylinder are filled with mercury by lifting the reservoir. The capillary tube can now be used as a pipette, and the gas is drawn into the cylinder and allowed to assume a constant temperature during the night at the pressure of the atmosphere. The bulb is then exhausted and placed in communication with the cylinder, and all the gas is driven into the bulb by raising the mercury flask. The bulb is then carefully removed, and dry air is allowed to enter so as to bring the pressure nearly up to that of the atmosphere. Lastly, the bulb is placed on the balance; the weight which has to be added or removed to obtain equilibrium represents p, which, substituted in the above equation, gives the density. The specimen of gas operated upon can be subsequently used for other experiments.—On the order of appearance of the first vessels in the flowers of some *Lactucæ*, by M. A. Trécul.—On the effects of cold and drought on this year's harvests, and the means by which it has been attempted to combat the evil, by M. Chambrelent.—On the alcoylcyanocamphors and the benzine-azocamphocarbonic ethers, by M. A. Haller.—On the *Libytherium maurusium*, a great Ruminant of the plaisancian pliocene formation of Algiers, by M. A. Pomel.—Measurement of the absolute intensity of gravity at Breteuil (International Office of Weights and Measures), by M. G. Defforges. This was carried out by means of two reversible pendulums constructed by the brothers Brunner, one being 1m., the other 0·5m. long between the knife-edges. The oscillations took place in air and in a vacuum, the latter being continued for 12 to 24, and once for 50 hours. The results were:—

For the length of the seconds pendulum......	0·993952
For g...	9·80991

—Photographs of the chromosphere, the prominences, and the solar faculæ, taken at the Kenwood Astro-physical Observatory, Chicago, by M. E. Hale.—On the practical calculation of the dimensions of the outflow orifices of saturated vapour into the atmosphere, under constant or varying conditions; application to safety valves, by M. H. Parenty.—On a chloro-nitrogen salt of palladium, by M. M. Vèzes.—Double chlorides formed by lithium chloride and the chlorides of the magnesium series, by M. A. Chassevant.—Researches on nickel and cobalt, by MM. Ch. Lepierre and M. Lachaud.—On the iodomethylates of quinine, by M. E. Grimaux.—On the camphocarbonic methyl ethers, methyl camphor, and some nitrogen derivatives of cyanocamphor, by M. J. Minguin.—Action of the metalloid nitrides and hydronitrides on the oxyhydrocarbon compounds, by M. R. Vidal.—On some ferruginous medicines, by M. H. Le Chatelier.—Contributions to the history of mineral waters; on the alumina contained in these waters, by M. F. Parmentier.—The respiratory value of hæmocyanine, by M. L. Cuénot.—Physiological action of spermine; interpretation of its effects on the organism, by M. Alexandre Poehl.—On the embryonic circulation in the head of the axolotl, by M. F. Houssay.—On the *Belisarius Viguieri*, a new fresh-water copepod, by M. Maupas.—On the evolution of the embryo of a fowl submitted during incubation to a continuous rotation, by M. Dareste.—The boghead of Autun, by MM. C. Eg. Bertrand and B. Renault.—On the constitution of the fructifying ears of *Sphenophyllum cuneifolium*, by M. R. Zeiller.—A review of the geological constitution of the regions situated between Bembé and Crampel Peak (Congo), after specimens collected by M. Jean Dybowski.

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THURSDAY, JULY 28, 1892.

GROUSE DISEASE AND FOWL ENTERITIS.

The Etiology and Pathology of Grouse Disease and Fowl Enteritis. By E. Klein, M.D., F.R.S. (London: Macmillan and Co. 1892.)

IN this book Dr. Klein has given the results of an important series of researches made by him upon certain diseases in birds. The malady which has specially occupied his attention is that commonly known as the grouse disease. The book will therefore find a large and appreciative circle of non-professional readers. To all interested in the preservation of game it may be commended as furnishing for the first time an adequate and satisfactory explanation of the origin and mode of propagation of the grouse disease. The book is over and above that a valuable contribution to bacteriology. The very excellent illustrations appended enable one to follow the text with great ease. The birds affected are the red grouse (*Lagopus scoticus*) of our moors. The disease, when it breaks out in the spring or summer, is usually of a very virulent type. A fatal epidemic then arises which carries off large numbers of the birds, to the despair of the owners and keepers, who find themselves powerless to cope with the malady. It is to this quickly fatal epidemic that the name of the grouse disease is applied. Though much written about and much discussed, the origin of this disease has hitherto remained undiscovered.

During the last five years numbers of birds, dead or dying from the disease, were sent to Dr. Klein from moors in England and Scotland. The large amount of material furnished has enabled him to make an exhaustive inquiry.

The result is the most noteworthy account yet published of the etiology and pathology of the disease. Dr. Klein has proved that it is an acute infectious malady primarily affecting the lungs and liver of the birds. The symptoms and appearances are those of an acute infectious pneumonia. Dr. Klein has further discovered the *causa causans* of the disease in the shape of a minute unicellular organism, belonging to the class of the bacteria. This microbe has its special seat in the lungs and liver. It is a bacillus, and is found filling and blocking up the capillary blood vessels in the diseased areas of the lungs and liver. The organism can be isolated from the diseased tissues and grown on suitable media outside the body. In this way a series of culture of the bacilli were made on various soils—gelatine, Agar, beef broth, &c. The manner of growth of the microbe in these culture media is very fully described. The growths obtained were always of the same bacterial species. The pure culture of the bacillus subcutaneously inoculated into healthy animals reproduced the symptoms and appearances of the disease. They proved fatal to mice and guinea pigs, and caused in them a congestion of the lungs and liver. No effect was produced on pigeons and fowls. The most virulent cultures of the microbe were those grown in meat broth to which a piece of coagulated white of egg had been added. The most positive results were obtained with the common bunting and yellow-ammer. These birds were inoculated with a minute drop of a meat-broth culture of the microbe. They succumbed within twenty-four hours. The post-mortem appearances were similar to those found in the grouse, viz., a marked congestion of the lungs and liver. The bacilli were found in large numbers in the lungs. From these experiments Dr. Klein was able to conclude that the grouse disease is due to the microbe isolated by him from the diseased organs of the birds. Unfortunately he has not been able to reproduce the disease in large birds, or to utilize healthy grouse for his experiments. In the latter case the difficulty in obtaining living birds and keeping them in captivity prevented this last and most important proof being furnished. The larger birds experimented with (fowls and pigeons) proved unsusceptible.

The infection of the birds seems to take place through the respiratory organs. Dr. Klein furnishes a very striking experiment in support of this view. A yellow-ammer, after being inoculated with the grouse bacillus, was placed in a cage adjoining to one containing six healthy ammers. These six healthy birds acquired the disease and died.

The autumnal disease of the grouse is similar to the spring and summer disease, and both are caused by the same microbe.

The bacilli found in the autumnal disease are, however less virulent than those found in cases during the spring and summer. The buntings and ammers inoculated with the autumn microbe died at a much later period. Mice that had survived inoculation with the autumn microbe did not succumb when inoculated with the more virulent spring microbe. Dr. Klein suggests that cultures of the autumnal microbe might be used as a protective vaccine for the young birds on the moors. It is to be feared that those on whose shoulders this task would fall might prefer the disease to the cure.

The bacillus is easily killed. A temperature of 60° C. completely destroys its life in five minutes. On the other hand, virulent meat broth cultures heated for twenty minutes to 55° C., retained their virulence and yielded normal growths when grown in a fresh soil. This more prolonged heating so near the critical temperature for the bacilli (60° C.) did not, as one would have supposed, produce any retardation in their subsequent growth or any attenuation of the organisms.

Meat broth cultures, in which the bacilli had been destroyed by heat, produced in mice all the symptoms of the disease. This points to the presence in the meat broth of some poisonous chemical product. The matter is referred to very briefly, but we hope Dr. Klein will soon be in a position to tell us more about this interesting and important discovery.

To prevent the spread of the grouse disease the importance of weeding out suspicious birds from the moors is emphasized. The birds killed should be removed and burned.

Dr. Klein describes in the next place a bacillus which he isolated from garden earth. Guineapigs, rabbits, and mice, when inoculated with this organism, developed an œdema of the subcutaneous and muscular tissues. The organism is aerobic, and grows well in the presence of free oxygen, and on the surface of culture media. It is therefore not identical with Koch's bacillus of malignant œdema, which is an anaerobic organism. Though it resembles the bacillus of grouse disease in certain respects, they are not to be regarded as one and the same microbe.

The second part of the book contains an account of a fatal epidemic amongst fowls which broke out at Orpington in Kent. The symptoms and post-mortem appearances led Dr. Klein to designate the disease fowl enteritis, in order to distinguish it from fowl cholera. The bacillus which is the cause of fowl enteritis is not identical with the bacillus of fowl cholera, and Dr. Klein clearly proves this.

Dr. Klein's bacillus is evidently a less virulent organism. In only one case was the disease produced by feeding fowls with the intestinal contents of a diseased fowl. Experiments on other animals gave practically negative results, except in the case of one rabbit. The virulence of the bacilli was lessened by heat. Fowls inoculated with this attenuated virus could not be infected with the disease. Some practical suggestions are given with a view to combating such epidemics.

The concluding chapter of the book contains an interesting account of a disease in young pheasants known as "Cramps."

We have given but a very brief account of Dr. Klein's important investigations. The book will, however, be read by every one interested in the subjects of which it treats, and with great profit. To other workers in the same field it will prove an indispensable work of reference. We have only detected one misprint, on page 53, where "50° Fahr." should no doubt have read 50°C.

We cannot close this notice without a word of praise for the excellent photograms of Mr. Pringle and Mr. Bousfield. A. M.

ELECTRIC LIGHT CABLES.

Electric Light Cables. (London: Whittaker and Co., 1892.)

A DOZEN years ago, when dynamos and lamps, both arc and incandescent, had been pretty well developed, the general public arrived at the conclusion that it was time to commence the work of central station lighting by electricity. It was not until the plans of these proposed works were taken in hand by the consulting engineers that the difficulties in the way of distribution became fully apparent. It was not well known what strength of current could be safely carried through the conductors; and engineers were rather appalled at the cost of the copper required for maintaining uniform pressure over a district, and at the waste of energy in the conductors. Besides these theoretical troubles in the way, engineers were met by the practical difficulty of devising a secure and efficient means of laying conductors under the streets, and ensuring their proper insulation. Until recently, the rules which must be attended to by engineers to enable them to handle these questions were only to be found in scattered pamphlets and Proceedings of societies. Several scientific men dealt independently with the heating of the conductors, and finally Mr. Kennelly published his splendid experimental work on the subject. Other writers went fully into the economical principles which must be followed in order to secure the most uniform distribution at the least cost. When the alternating-current rendered the employment of high pressures both safe and convenient, many of these precautions became less necessary, but new problems arose which are also generally dealt with only in isolated papers. Inventors sprang up, each advocating his own system of laying mains, and an outsider can gain a knowledge of these only by reading the patent specifications, or by inspecting the progress of works. The mechanical details of making joints, insulating, and so forth, are not much dealt with in the literature of the subject.

The book before us is one of the first attempts to collect all the above principles within one binding. The first few chapters deal principally with the heating of conductors and the economical laws of distribution. Well-known writings on the subject are here condensed into convenient compass, and Kennelly's experimental results are given in sufficient detail. Series and parallel systems and their combinations, including the three-wire and five-wire systems, which serve so much to economise copper, are explained, and also the principles involved in the use of transformers with alternating currents. Having thus described the systems available, we have, in Chapter v., a useful account of the cost of cables and conduits, with tables showing the relative cost of different systems when the distribution extends to different distances, showing the advantages of using high pressure for long distances. Chapter vi. gives a number of practical data about different kinds of conductors and the manner of making joints, which, though not exhaustive, will be of use to many. The next chapters deal with the characters of the insulation, including air insulation, lead-covered cables, the various bituminous compounds known as bitite, &c., oil insulation, and, of course, vulcanized india-rubber, about which the author is particularly capable of giving information. The effects of capacity, which has given so much trouble at some central stations, are also alluded to. These chapters are very fairly written, and give as good an account of the various systems of insulation as is likely to be found anywhere, or as we might expect in a volume of this size, which is more a hand-book of the subject than an exhaustive treatise. Some of the principles of testing are then shortly, but very clearly, described; and the principles of house wiring are clearly shown, and safety devices described. Several good chapters come near the end of the book on the practical construction of lines, whether overhead or underground, the latter dealing chiefly with the actual work which has been done in London of late years.

This book is one of the best which could be taken up by the student to give him a general knowledge of what is involved in the comprehensive title—"The Distribution of Electricity." It does not pretend to be a complete manual for the office, containing all the information required by the consulting engineer in dealing with these problems, but the descriptions are clear and generally accurate, and the only criticism which we feel compelled to make is that sometimes, apparently with the desire of preventing the book from being too technical, or requiring too much mental effort to read it, the author has been, perhaps, a little too sketchy, and might with advantage have given some more detailed information on a variety of points. Nevertheless, we consider that this book is a useful addition to electrical literature, and must be of the utmost use to students in showing the difficulties which have to be encountered in designing a plan of central station working. The general reader will also be much interested in learning something more of the meaning of the work which he sees being carried out at present in the streets of many of our towns. Should the book chance to fall into the hands of any members of electric lighting committees of Municipal Corporations, it will do a vast amount of good, by opening their eyes as to the number of problems that have to be considered in their dealings with different contractors, each generally wedded to a special system. It is to be hoped that this book will teach them that, in trying to act as consulting engineers without the special training necessary, they are not serving the best interests of the towns they represent. Altogether, "Electric Light Cables" is a useful addition to the literature of electrical engineering, and the absence of too many technicalities will make it popular with a large class of readers.

OUR BOOK SHELF.

Distribution de l'Electricité. I. "Installations isolées." II. "Usines centrales." Par R. V. Picou, Ingénieur des Arts et Manufactures. (Paris: Gauthier-Villars, 1892.)

THESE two small volumes are portion of a series belonging to "L'Encyclopédie scientifique des Aide-Mémoire," published under the direction of M. Léauté, Member of the Institute. The second volume is the only one which calls for remark. It deals with the methods, well known in England, of distribution of continuous and alternating currents and systems of high and low pressure. The information given concerning the multiphase and rotary current systems is very scanty and quite out of proportion to the other matters treated of. The reader will naturally look for an account of the method employed for the transmission of power from Lauffen to Frankfort, but he will find no information of any practical service. The author, however, gives a short discussion of the difficulties that must be surmounted if arc and incandescent lamps are to be installed on a circuit fed by a triphaser and three wires.

Information is given concerning the working of some of the principal existing central stations, and there is a useful bibliography.

Popular Readings in Science. By John Gall, M.A., LL.B., and David Robertson, M.A., LL.B., B.Sc. (Westminster: Constable and Co., 1892.)

THIS forms the second volume of Constable's Oriental Miscellany of original and selected publications, and is intended to form the basis of a general course of instruction in science, suited to the requirements of the pupils in Indian schools who are preparing for matriculation at the University. The authors lay no claim to originality, but have exercised a judicious choice in the selection of subject matter. The first chapter deals with meteorology, special prominence being given to Mr. Blandford's researches on the climate of India. Then follow chapters on the vegetable kingdom, evolution, both in its biological and chemical aspects, mimicry, the nebular hypothesis, tidal evolution, energy, the spectroscope, molecular forces, and Bacteria. A reference to the meteoritic hypothesis would make the chapter on the nebular theory more complete. The authors have wisely contented themselves with *descriptions* of theories and plain matter-of-fact statements. The book is very readable, but at times somewhat technical. It would, however, be improved by the addition of more diagrams, though it may be that more can safely be left to the imagination of the Oriental than the Western mind. The narrative style which has been adopted by the authors will make the book acceptable to general readers who are anxious to make acquaintance with modern science.

Geometrical Deductions, Book II. By James Blaikie and W. Thomson. (London: Longmans, Green, and Co., 1892.)

THIS treatise is intended to afford a systematic course of training in the art of solving geometrical problems. The basis of the system which the authors have employed is to be thoroughly recommended, being both logical and simple. The book is divided into sections, each of which consists of three parts. In the first a model deduction is fully worked out to illustrate the method of solution; then follow similar deductions with their figures, and occasional hints; while, lastly, the student is left to himself to solve the problems without any such aid. This principle is maintained throughout the entire book, so that a student should be able to obtain a good working knowledge and should also to a great extent be quite rid of a teacher.

The Appendices will also be found very useful, as they contain the enunciations of the propositions in Euclid's second book and of standard theorems and loci, together with a set of miscellaneous deductions covering the range of Euclid's first two books.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

B.A. Procedure.

THE coming meeting of our ancient and venerable institution, the British Association *for the Advancement of Science*, will doubtless be a large one, as the beauties of Edinburgh are sure to tempt many to attend, and may therefore give opportunity for discussion on a subject of fundamental importance—the future well-being of the Association and the means of retaining it as an object of veneration on account of the services which it *is* rendering and not merely on account of those which it *has* rendered.

It is beyond question that there are many who have long been dissatisfied, and who are of opinion that B.A. procedure is not in harmony with the times. Moreover, to speak plainly, many of us feel that the "tripper" element has become too predominant, and that the credit of science will suffer if a large number of persons be permitted, year after year, to make pleasant holiday, "supported by voluntary contributions," under the pretence of advancing science, while the number of true workers whose reputation alone upholds the claim of the Association to public recognition is but small.

In the great majority of instances the reading of papers on technical questions in the sections has become little less than a solemn and dreary farce played to almost bare benches; and it is only in exceptional cases—such as Section A affords—that a small and devoted body of true believers worship at an inner shrine without regard to the general public, and are thus able among themselves to do work of high value to science.

The B.A. should exercise an influence in two directions—it should advance scientific knowledge among scientific workers; and it should aid the general public in understanding and appreciating scientific work, its methods and results. It may effect the former by bringing scientific workers together and giving them due opportunity for the interchange of knowledge and opinions. To secure this end, it is important that *sectional* and *intersectional discussions* should, in future, become *the feature* of the meetings, but to be successful these must be conducted with far greater forethought than heretofore—they must be true discussions and must not consist of a number of short papers written without reference to each other or to any central idea, and there must be no limitation of discussion so long as it is to the point. Probably the best plan will be that sectional committees, specially appointed for the purpose, select subjects, and that on each of these some one open a discussion by means of a carefully-prepared paper, printed and circulated at least a month beforehand, among those likely to take part in the debate. Such discussions should be carefully reported, and the edited report should be subsequently published, those who had taken part in the discussion having full liberty allowed them to give expression to their carefully-considered opinions instead of being required merely to punctuate their sentences in proof. The resolution not to report discussions arrived at last year by the Council is most unfortunate. If it were understood that discussions would be reported, speakers would be far more interested, and would take far more pains in preparing to take part in them than has hitherto been the case. It is, I think, unnecessary to dwell on the value of true discussion among workers in different, but cognate, branches of science.

As regards the public functions of the Association, it is unquestionable that much more might—and should—be done on behalf of those who are interested spectators rather than active workers in science. The evening lectures now delivered are often very brilliant expositions, but, as a rule, they have been "above the heads" of a very large proportion even of the members of the Association who have listened to them. I know many who think with me that a more direct effort should now be made to advance the knowledge of science among the general public at these meetings.

One great reform which *must* be carried out is the general curtailment of the expenses of the meetings, which make it impossible for any but the largest and richest towns to receive the Association. The lavish expenditure on the Reception Room which has been so frequently witnessed of late years should be unnecessary. So long as we can come together and can accomplish our object—the *advancement of science*—we should be satisfied with the most modest accommodation and should even be prepared to submit to some privation. At the German Naturforscher Versammlungen the vast majority cater for themselves, and private hospitality is almost unknown, the social demon, which is so ruthless a destroyer of much of the effectiveness of the B.A. meetings, being kept entirely in the background; and yet, in my opinion, these meetings are at least as enjoyable and fruitful of result as our own B.A. meetings.

Then we want younger presidents, on the average—men who are in their prime as scientific workers.

Of late years our Council has been far too cautious and conservative a body, and a large infusion of a liberal and progressive element is necessary if we are to set our house in order, so that it may suit the times. Many of us think that the Council is not in touch with us as a body—somehow we know of its existence, but its functions are mystic and akin rather to those of the Archives of the Royal Society than to those of an energizing and propulsive organ. In these democratic days, it would be well if each section were to return a member to Council.

HENRY E. ARMSTRONG.

The Position of 4π in Electromagnetic Units.

THERE is, I believe, a growing body of opinion that the present system of electric and magnetic units is inconvenient in practice, by reason of the occurrence of 4π as a factor in the specification of quantities which have no obvious relation with circles or spheres.

It is felt that the number of lines from a pole should be m rather than the present $4\pi m$, that "ampere turns" is better than $4\pi n$C, that the electromotive intensity outside a charged body might be σ instead of $4\pi\sigma$, and similar changes of that sort; see, for instance, Mr. Williams's recent paper to the Physical Society.

Mr. Heaviside, in his articles in the *Electrician* and elsewhere, has strongly emphasized the importance of the change and the simplification that can thereby be made.

In theoretical investigations there seems some probability that the simplified formulæ may come to be adopted—

μ being written instead of $4\pi\mu$, and k instead of $\frac{4\pi}{K}$;

but the question is whether it is or is not too late to incorporate the practical outcome of such a change into the units employed by electrical engineers.

For myself I am impressed with the extreme difficulty of now making any change in the ohm, the volt, &c., even though it be only a numerical change; but in order to find out what practical proposal the supporters of the redistribution of 4π had in their mind, I wrote to Mr. Heaviside to inquire. His reply I enclose; and would merely say further that in all probability the general question of units will come up at Edinburgh for discussion.

OLIVER J. LODGE.

Paignton, Devon, July 18, 1892.

MY DEAR LODGE,—I am glad to hear that the question of rational electrical units will be noticed at Edinburgh—if not thoroughly discussed. It is, in my opinion, a very important question, which must, sooner or later, come to a head and lead to a thoroughgoing reform. Electricity is becoming not only a master science, but also a very practical science. Its units should therefore be settled upon a sound and philosophical basis. I do not refer to practical details, which may be varied from time to time (Acts of Parliament notwithstanding), but to the fundamental principles concerned.

If we were to define the unit area to be the area of a circle of unit diameter, or the unit volume to be the volume of a sphere of unit diameter, we could, on such a basis, construct a consistent system of units. But the area of a rectangle or the volume of a parallelepiped would involve the quantity π, and various derived formulæ would possess the same peculiarity. No one would deny that such a system was an absurdly irrational one.

I maintain that the system of electrical units in present use is founded upon a similar irrationality, which pervades it from top to bottom. How this has happened, and how to cure the evil, I have considered in my papers—first in 1882–83, when, however, I thought it was hopeless to expect a thorough reform; and again in 1891, when I have, in my "Electromagnetic Theory," adopted rational units from the beginning, pointing out their connection with the common irrational units separately, after giving a general outline of electrical theory in terms of the rational.

Now, presuming provisionally that the first and second stages to Salvation (the Awakening and Repentance) have been safely passed through, which is, however, not at all certain at the present time, the question arises, How proceed to the third stage, Reformation? Theoretically this is quite easy, as it merely means working with rational formulæ instead of irrational; and theoretical papers and treatises may, with great advantage, be done in rational formulæ at once, and irrespective of the reform of the practical units. But taking a far-sighted view of the matter, it is, I think, very desirable that the practical units themselves should be rationalized as speedily as may be. This must involve some temporary inconvenience, the prospect of which, unfortunately, is an encouragement to shirk a duty; as is, likewise, the common feeling of respect for the labours of our predecessors. But the duty we owe to our followers, to lighten their labours permanently, should be paramount. This is the main reason why I attach so much importance to the matter; it is not merely one of abstract scientific interest, but of practical and enduring significance; for the evils of the present system will, if it continue, go on multiplying with every advance in the science and its applications.

Apart from the size of the units of length, mass, and time, and of the dimensions of the electrical quantities, we have the following relations between the rational and irrational units of voltage V, electric current C, resistance R, inductance L, permittance S, electric charge Q, electric force E, magnetic force H, induction B. Let x^2 stand for 4π, and let the suffixes $_r$ and $_i$ mean rational and irrational (or ordinary). Also let the presence of square brackets signify that the "absolute" unit is referred to. Then we have—

$$x = \frac{[E_r]}{[E_i]} = \frac{[V_r]}{[V_i]} = \frac{[H_r]}{[H_i]} = \frac{[B_r]}{[B_i]} = \frac{[C_i]}{[C_r]} = \frac{[Q_i]}{[Q_r]};$$

$$x^2 = \frac{[R_r]}{[R_i]} = \frac{[L_r]}{[L_i]} = \frac{[S_i]}{[S_r]}.$$

The next question is, what multiples of these units we should take to make the practical units. In accordance with your request I give my ideas on the subject, premising, however, that I think there is no finality in things of this sort.

First, if we let the rational practical units be the same multiples of the "absolute" rational units as the present practical units are of *their* absolute progenitors, then we would have (if we adopt the centimetre, gramme, and second, and the convention that $\mu = 1$ in ether)

$$\begin{aligned}
[R_r] \times 10^9 &= \text{new ohm} = x^2 \text{ times old.} \\
[L_r] \times 10^9 &= \text{new mac} = x^2 \quad ,, \quad ,, \\
[S_r] \times 10^{-9} &= \text{new farad} = x^{-2} \quad ,, \quad ,, \\
[C_r] \times 10^{-1} &= \text{new amp} = x^{-1} \quad ,, \quad ,, \\
[V_r] \times 10^8 &= \text{new volt} = x \quad ,, \quad ,, \\
10^7 \text{ ergs} &= \text{new joule} = \text{old joule.} \\
10^7 \text{ ergs per sec} &= \text{new watt} = \text{old watt.}
\end{aligned}$$

I do not, however, think it at all desirable that the new units should follow on the same rules as the old, and consider that the following system is preferable :—

$$\begin{aligned}
[R_r] \times 10^8 &= \text{new ohm} = \frac{x^2}{10} \times \text{old ohm.} \\
[L_r] \times 10^8 &= \text{new mac} = \frac{x^2}{10} \times \text{old mac.} \\
[S_r] \times 10^{-8} &= \text{new farad} = \frac{10}{x^2} \times \text{old farad.} \\
[C_r] \times 1 &= \text{new amp} = \frac{10}{x} \times \text{old amp.} \\
[V_r] \times 10^8 &= \text{new volt} = x \times \text{old volt.} \\
10^8 \text{ ergs} &= \text{new joule} = 10 \times \text{old joule.} \\
10^8 \text{ ergs per sec.} &= \text{new watt} = 10 \times \text{old watt.}
\end{aligned}$$

It will be observed that this set of practical units makes the ohm, mac, amp, volt, and the unit of elastance, or reciprocal of permittance, all larger than the old ones, but not greatly larger, the multiplier varying roughly from $1\frac{1}{4}$ to $3\frac{1}{2}$.

What, however, I attach particular importance to is the use of one power of 10 only, viz. 10^8, in passing from the absolute to the practical units; instead of, as in the common system, no less than four powers, 10^1, 10^7, 10^8, and 10^9. I regard this peculiarity of the common system as a needless and (in my experience) very vexatious complication. In the 10^8 system I have described, this is done away with, and still the practical electrical units keep pace fairly with the old ones. The multiplication of the old joule and watt by 10 is, of course, a necessary accompaniment. I do not see any objection to the change. Though not important, it seems rather an improvement. (But transformations of units are so treacherous, that I should wish the whole of the above to be narrowly scrutinized.)

It is suggested to make 10^9 the multiplier throughout, and the results are :—

$$\begin{aligned}
[R_r] \times 10^9 &= \text{new ohm} = x^2 \times \text{old ohm.} \\
[L_r] \times 10^9 &= \text{new mac} = x^2 \times \text{old mac.} \\
[S_r] \times 10^{-9} &= \text{new farad} = x^{-2} \times \text{old farad.} \\
[C_r] \times 1 &= \text{new amp} = \frac{10}{x} \times \text{old amp.} \\
[V^r] \times 10^9 &= \text{new volt} = 10x \times \text{old volt.} \\
10^9 \text{ ergs} &= \text{new joule} = 10^2 \times \text{old joule.} \\
10^9 \text{ ergs p. sec.} &= \text{new watt} = 10^2 \times \text{old watt.}
\end{aligned}$$

But I think this system makes the ohm inconveniently big, and has some other objections. But I do not want to dogmatize in these matters of detail. Two things I would emphasize :—First, rationalize the units. Next, employ a single multiplier, as, for example, 10^8.

OLIVER HEAVISIDE.

P.S.—Heaven preserve us from dynamics based on the Act of Parliament!

Neutral Point in the Pendulum.

In the theory of the pendulum the position of the neutral point of support is a matter of practical importance, which is, nevertheless, quite disregarded.

Taking a rigid uniform bar as the simplest case, there are four points of support from which its vibrations are equal, the two ends and the two respective centres of oscillation. But there are two symmetric points, situated between either end and the centre of oscillation nearest to that end, from which points of suspension the rate of vibration is most rapid. Hence, when suspended from these points, a change in the position of the point of support produces a minimum difference in the rate of vibration. Or, in practical terms, there is a great advantage in having a small amount of overhead weight above the support, as then, if the support approach the bob (owing to changes in elasticity of the spring, or of the knife edges), and so increase the number of vibrations, it recedes from the top weight, and so diminishes the vibrations to a corresponding amount, and *vice versa*.

This neutral point of support seems to have been overlooked in the main pendulum researches, as it was what had to be avoided rather than sought in the determination of the length, which was then the main interest. Probably some one has already noticed such an elementary property; but it is of so much value in minimizing sources of error that it is worth some attention.

Bromley, Kent. W. M. FLINDERS PETRIE.

Induction and Deduction.

CAN we determine the precise relation between Induction and Deduction? Both are said to be a species of Inference. *Deduction* is, no doubt, Mediate Inference. Is *Induction* Mediate or Immediate Inference? If Immediate it must be of the form :

This X is Y (or these X's are Y's) . . . . . (1)
∴ All X's are Y's . . . . (2)

But such "inference" as this is not illative; (1) can furnish only a suggestion, not by any means a justification, of (2).

Still it is true that if, *e.g.* I have proved that the angles at the base of an isosceles triangle are equal to each other, I henceforth believe and assert unhesitatingly, that *all* isosceles triangles have the angles at the base equal. *How* do I justify such a conclusion of an universal from a particular? In this way, I think :—Every nameable or cogitable object is an identity in diversity—that is, it is itself, it is *something*, and it has a plurality of characteristics. This principle is involved in the assertion of any statement of the form *A is* B, and it seems moreover to be, in itself, evident on reflection. Further (as Bacon surmised), every property (or group of properties) has a "form," some invariable and inevitable coexistent. In other words, there is uniformity of coexistence as well as of causation in nature. In the case of any one isosceles triangle, I have *seen* the connection of interdependence that there is between the characteristics of "having equal sides," and "having the angles at the base equal;" I have perceived it to be self-evident that the one property involves the other. Hence, my whole argument might run thus :—

Every characteristic is invariably accompanied by some other characteristic;

Equality of sides in a triangle is a characteristic;

∴ Equality of sides in a triangle is invariably accompanied by some other characteristic.

Again :—

Equality of angles at the base is a characteristic which is (self-evidently) inseparable from equality of sides in one [this particular] case;

What is inseparable from equality of sides in one case is inseparable in all cases;

∴ Equality of angles at the base is inseparable from equality of sides in all cases—

That is, *all* isosceles triangles have the angles at the base equal.

What we rely on here is Interdependence of characteristics and Uniformity of that interdependence; *i.e.* we rely on a principle of coexistence or coinherence, parallel to Mill's "Law of Causation"; and this is a principle which we find to be a necessary condition of what we accept as strictly self-evident propositions. The assertion with which we conclude in the above generalization, is an assertion of uniformity of interdependence between certain specified characteristics.

Again, if I administer a certain amount of arsenic to a healthy animal, and it dies, and I hence conclude that arsenic is a cause of death, I argue thus:—Since every event (= change of attributes in subjects) has a cause, the death in question had a cause; the only precedent event that was relevant, was the administration of arsenic, therefore the arsenic was in this case the cause of death (this last result is obtained by the Method of Difference—by it we prove cause—*i.e.* interdependence of successive events). But (by the principle of uniformity) if arsenic is on one occasion cause of death, it is always cause of death; therefore arsenic is always a cause of death.

It will be observed that in this second induction, though not in the first, we make use of one of Mill's "Inductive Methods." The function of these Methods is to prove interdependence between phenomena—whether it be an interdependence of concomitance or of causation. In the case of the Method of Difference we proceed on the assumption that if the introduction of A is followed by the appearance of C, or the removal of A by the disappearance of C, then A and C are causally interdependent. In the Method of Agreement we proceed on the assumption that if A is never found without C, A has a connection of interdependence with C.

We do not use, and do not need, these Methods in mathematical generalizations, because there we *see* the interdependence upon which generalization to unknown cases is based; it is this actual apprehension of interdependence that both makes the methods unnecessary and gives mathematical generalizations the peculiar certainty which is generally attributed to them. In the case above cited, for instance, we *see* that equality of angles at the base is self-evidently and necessarily bound up with equality of sides in a triangle. We do *not* see that there is a self-evident interdependence between the obvious properties of arsenic and poisonousness.

A further interesting point is that our power of predicting that one event, A, will be *followed* by another event, C, seems to depend wholly upon *coexistence* of attributes in the subjects concerned. If we have seen one animal dosed with arsenic and subsequently die, and hence conclude that another animal called by the same name, and dosed with an equal amount of arsenic, will die, is not our inference based upon the assumption of a certain constant coinherence of attributes, both in the animal and in the poison—a coinherence of such a kind that when the two subjects are so collocated as to act upon each other, a result similar to that produced in the first case will be produced in the second also? If the properties of this arsenic are different from the other, or if the second animal, though looking like the first, has a different internal constitution, there is no reason why death should result. Hence, laws of succession in events seem to depend upon laws of coexistence of attributes in subjects.

Even those generally unquestioned axioms of logic, the Law of Contradiction and the Law of Excluded Middle, might be appealed to (if it were necessary) in support of the Principle of Interdependence—for the Law of Excluded Middle intimates a thoroughgoing connection (positive or negative) between all nameable things; and the Law of Contradiction asserts a certain definite amount of necessary interdependence of properties in every imaginable case—interdependence, namely, between *the presence of any characteristic* and *the absence of its negative*.

Looking at the whole process of inductive reasoning, it appears to be in the application of the "Methods" that the principles used approach nearest to the character of mere assumptions; and this is so only because of the difficulty of applying the Methods precisely—of being sure, *e.g.* in the case of the arsenic, that the administration of arsenic *was* the only new antecedent relevant to death.

It may just be noticed that in an argument by analogy we rely upon an interdependence which is inferred from the complexity or amount of interdependence already known or supposed.

If the above account of inductive reasoning is accepted, it appears that the connection between Induction and Deduction is very close—in fact, that the one distinctive feature of logical induction is the element of hypothesis or discovery—the supposition of a given connection—from which every Induction must set out.

Cambridge. E. E. Constance Jones.

The Scale for Measurement of Gas Pressures.

I venture to ask you to print the following suggestion. It is one likely enough to have been made before, but I do not remember having met with it.

We generally measure gaseous pressures in millimetres of mercury, and 760 mm. is adopted as the standard pressure. It would certainly be more convenient if we expressed the measurement in degrees, the degree being of such magnitude that the standard pressure were 273°. All calculations involving change of P, T, and V to or from the standard conditions would be simplified in an obvious way. The equation $PV = RT$ would become $V = R$ at standard pressure and temperature. R being the same constant for all gases under all conditions, if V stand for the molecular volume, it would be convenient to remember it as identical with the well-known number expressing the standard volume of a gramme-molecule. 1°P would correspond to about 2·78 mm. or ⅑ inch of mercury.

Orme Masson.

The University of Melbourne, June 21.

Luminous Clouds.

Bright luminous clouds were seen here on the night of Sunday the 24th inst., in the north and north-north-east, from 9.35 to 10.35 p.m. As usual they distinctly resembled *cirri*, having some definite upward curls. The actual cirri, which had after sunset been moving rapidly from east-south-east, now appeared dusky against the twilight glow. The filature of the upper or luminous cirri was, as appears to be usual, west and east, while that of the ordinary cirri was east-south-east and west-north-west.

These luminous clouds, although no doubt simply reflecting solar light, generally appear to the casual observer as incandescent or self-luminous.

They were seen from the summit of Ben Nevis all through the night of the 24th–25th, according to the report in the *Times*.

Lutterworth. W. Clement Ley.

Whirlwinds in the South Indian Ocean.

The following account of whirlwinds met with in the South Indian Ocean at the end of last May, which has been supplied to the Meteorological Office by Messrs. Sandbach, Tinne & Co., of Liverpool, may be of interest to your readers.

Robert H. Scott,
July 22. Secretary, Meteorological Office.

Extract from a Letter received from Capt. S. P. Hearn, Ship "Genista."

"At noon on May 26, lat. 42° 0′ S., long. 99° 0′ E., wind fresh from N.W.—weather very squally with rain, barometer steady at 29·82 in., thermometer 49° since midnight. A very heavy black squall with rain began to rise in the W. Barometer suddenly fell 0·1 in. As the squall neared the ship it arched up in the centre, showing a very bright blue sky at the back of it; the ends of the squall on either side were quite black and thick with rain. On its nearer approach to the ship I saw two immense whirlwinds, just a little on either side of the centre of the arch and coming direct for the ship, the sea under and near the whirls being carried around and up in great volumes. I thought at first they were two waterspouts forming, but I saw no descending column or clouds from above, as is seen when a waterspout is forming; when these whirls came to within two miles of the ship, the squall seemed to part in the centre of the arch—one half passing to the N.E., the other half to the S.E., one whirl following in rear of each part of the squall, and not where the clouds were heaviest. During the time of the separation of the arch we had the wind very unsteady from N.W. to S.W. There was only a fresh breeze with thick rain in that part of the squall that neared the ship; yet the squall was travelling along at a great rate, the whirls keeping in the rear till out of sight. I shortened sail to topsails as soon as I saw the squall rising. After it passed, the weather looked very fine, bright, and clear, but the sky was a windy one, being a very bright blue. By 3 p.m. the wind shifted to W., and barometer had fallen to 29·67 in., thermometer 48°. At 4 p.m. saw another whirl passing along to windward in the rear of a squall, the clouds above it being twined and twisted every way. During the whole night we had very heavy squalls, sometimes following one another very quick, with little wind between—direction W.S.W. At daylight the weather was much finer. After that, to lat. 40° 22′ S., long. 125° E., I had very peculiar weather. Wind from N.W. to S. and back again, from a light breeze to a moderate gale, barometer never rising higher than 29·90 in., or falling below 29·66 in.

The Cause of the Great Fire at St. John's.

A FEW days ago you inserted a letter calling attention to the large number of fatal accidents occurring every year caused by the upsetting of paraffin lamps, the great majority of which could easily be prevented if the use of automatic extinguishers were made compulsory.

Now we are startled by the report of the huge conflagration at St. John's, which, in addition to having caused terrible and widespread suffering, has resulted in the loss of a large amount of property, valued at many millions of dollars.

Amongst the principal sufferers by this great fire are some of the leading English insurance companies, and various estimates have been published of the amounts which they will lose by this great fire. *The Policy Holder*, an insurance journal, in its last issue, mentions the following figures :—

	£		£
Phœnix	120,000	to	140,000
Royal	80,000	to	100,000
Liverpool, London, and Globe	50,000	to	70,000
London and Lancashire ...	50,000	to	60,000
Commercial Union	40,000	to	50,000
North British and Mercantile	50,000	to	60,000
Northern	40,000	to	50,000
Manchester	8,000	to	11,000
Lancashire	5,000	to	7,000
Norwich Union	7,000	to	10,000

Also the "General," said to be £30,000, and the "Lion" for a comparatively large sum, making in the aggregate a loss for English insurance companies alone of over £500,000 sterling.

The same journal explains how this great fire was brought about :—

"It is worthy of note that, like the Chicago fire, this conflagration was caused by the upsetting of an oil lamp in a stable. Fire business was already this year going badly enough, and there now seems little reason to doubt that to the companies as a whole 1892 will prove a disastrous year and a dead loss."

The Mayor of Manchester (Alderman Bosdin Leech), in presiding yesterday at a meeting of citizens called for the purpose of raising a fund in aid of the sufferers by this great catastrophe, stated—

"Since the fire of forty or fifty years ago many substantial public and private buildings had been erected, all of which have been destroyed. On one side, at any rate, a thriving town had been reduced to a heap of ashes, and about 10,000 people had been rendered homeless, and damage had been done to the extent of about 2,500,000 dollars. With such an event coming suddenly upon them, they could imagine how the people were prostrated. The heart of the people was completely crushed. A great many of the sufferers were of the poorest class, and they were almost powerless to help themselves. They were without food, except such as had been supplied to them through the kindness of their neighbours ; they were without clothes, for all their clothes had been destroyed ; and, unfortunately, the working people of the community had been almost entirely bereft of the tools and implements with which they were in the habit of earning their daily bread."

It is indeed very sad to think that this terrible calamity might have been avoided had the oil lamp which was the cause of all this mischief been fitted with a simple application of science in the shape of a simple automatic extinguisher.

July 20. HUMANITY.

THE WASHINGTON COLLECTION OF FOSSIL VERTEBRATES.

WE are pleased to learn from a transatlantic contemporary that the enormous collections of vertebrate remains, obtained under the superintendence of Prof. O. C. Marsh from the Tertiary and Secondary strata of the north-western United States, are about to be transferred to the National Museum at Washington, where they will eventually be properly arranged, and exhibited to the public. For the last nine years, as we are informed, the United States Government has voted funds for the collection and preservation of these wonderful remains, descriptions of which have been from time to time presented to the scientific world with a wealth of illustration which cannot but render European palæontologists somewhat envious.

Hitherto the whole of this collection (together with Prof. Marsh's private collection) has been stored in the palæontological department of the unfinished Peabody Museum, at Yale College, New Haven, Conn. ; where want of space has totally prohibited its proper exhibition. Indeed, those who have had the opportunity of inspecting this unrivalled series inform us that the specimens are so crowded together—the smaller ones in tier upon tier of trays, and the larger ones on the floors and in every available corner—that it has hitherto been quite impossible to form any adequate judgment as to the extent and importance of the collection. It is, however, satisfactory to learn that the whole series has been carefully labelled and registered, so that the locality and date of acquisition of every individual bone are fully recorded.

To prepare such an enormous collection for transit by rail is a work demanding both extreme care and a considerable amount of time ; while the Museum space required for the exhibition of entire skeletons of the bulk of those of the Jurassic and Cretaceous Dinosaurs must be proportionately extensive. We are informed, indeed, that if the whole collection were transferred to Washington at the present time it would occupy fully one-half of the buildings of the National Museum. Accordingly, only a portion of it is to be immediately transported ; while the remainder is to wait until Congress has provided suitable quarters for its reception. It is to be hoped that the moiety now to be transferred will include a representative selection from the entire series, so that palæontologists will have an opportunity of seeing more or less nearly entire skeletons, not only of the Dinosaurs and other huge Saurians of the Mesozoic, but likewise those of the equally wonderful Tertiary mammals. We may also venture to express the hope that the United States Government will before long see its way to enriching European Museums with some of their duplicate specimens, of which there must be a large number for disposal.

With a wise liberality, the Government of the United States appears to have made a regular business of the collection of these fossils, under the able direction of Prof. Marsh ; this business being conducted much after the manner of any other mining enterprise. One of the favourite hunting-grounds is the region lying between the "Rockies" and the Wasatch Mountains ; and the accounts of the richness of some of these deposits in vertebrate remains is absolutely marvellous. Thus Prof. Marsh is reported to know of one small valley where bones of Mosasaurians are in such profusion that in passing through it he observed at one time no less than six entire skeletons of these monstrous reptiles, each averaging some 80 feet in length. At such a rate of discovery it is no wonder that Museum accommodation cannot be procured fast enough. The care taken to prevent other fossil-hunters from discovering the more productive localities affords rather amusing reading ; but, under the circumstances, it is, perhaps, natural.

Whenever a likely-looking bone or skeleton is seen projecting from a rocky cliff, skilled workmen are at once set to work on its extraction ; a single specimen sometimes leading to the discovery of a regular golgotha of remains. The wonderfully perfect condition of some of these fossils, and the rapidity with which the carcasses of their former owners must have been entombed in sand or mud, are brought prominently under notice by a recent reported discovery in Wyoming. This is said to be nothing less than the disentombment of an entire skeleton of that stupendous Dinosaur known as the Brontosaur, in which not only is every bone in place, but an actual mould of the surface of the eye, formed in the sand upon which the creature lay, has been preserved in the solid rock.

Prof. Marsh's restoration of the Brontosaur—a creature 60 feet in length, walking on all fours, with an enormously long neck and tail, a disproportionately small head, and the bony substance of its backbone reduced to a mere shell and a honeycombed interior—has been long before the world. Less known, however, is his later reconstruction of the skeleton of one of the gigantic horned Dinosaurs from the Laramie Cretaceous, which he calls *Triceratops;* the skull and pelvis of which were referred to in an earlier number of NATURE. In this restoration the Professor has certainly succeeded in producing a most marvellous animal, although, so far as we see, the figure appears to be true to nature. It will be remembered that one of the most remarkable features in the skull of *Triceratops* (which in some specimens was upwards of 12 feet in length) is the production of the hinder regi on into a huge fan-like shield, the use and purpose of which it was at first a little difficult to understand. This is, however, explained by the restored skeleton, where we see this shield overlapping and protecting the first six vertebræ of the neck; to which additional strength was imparted by the bony union of several of them. In the shortness of its neck and the enormous size of its skull, *Triceratops* presents a striking contrast to *Brontosaurus.* Like the latter, however, it habitually walked on all fours; while in correlation with its massive skull its fore-limbs were relatively stouter than in any other Dinosaur. In this respect it differs widely from its near ally, *Stegosaurus*, which, at least occasionally, walked in a bird-like manner; and since *Triceratops* is evidently a more specialized creature than *Stegosaurus*, the suggestion arises that the former has undergone a retrograde development from a bipedal to a quadrupedal mode of progression. No attempt has yet been made to represent the position on the skeleton of the dermal bony armour with which many parts of the body of *Triceratops* were protected during life; the precise position of the various spines, knobs, and plates, which have been found in association with the bones, being largely a matter of conjecture. The size in life of the restored example would be approximately some 25 feet in length by 10 in height; but these dimensions must have been exceeded by other specimens.

By the completion (so far as anything connected with fossils can be said to be complete) of our knowledge of the skeleton of *Triceratops*, we are acquainted with the bony framework of all the chief types of Dinosaurian reptiles at present known. These may be classed as the Sauropodous type, as represented by *Brontosaurus;* the Theropodous type, as represented by *Megalosaurus* and its allies; and the Ornithopodous modification, represented on the one hand by *Iguanodon*, and on the other by *Stegosaurus*, *Triceratops*, &c.

In the contemporary publication to which we have referred some interesting suggestions as to the probable habits of these Dinosaurs are put forth, although how far they will meet with acceptation remains to be seen. Thus it is suggested that the honeycombed vertebræ of the Brontosaurs and their allies were filled with warm air from the lungs (which assumes that these reptiles were warm-blooded), by which means their bodies were partly floated when they wandered out of their depth in the sea shallows, from whence they stretched their long necks to crop the seaweed near the shore. Again, the long hind legs of the Hadrosaur (an ally of our Iguanodon) are considered to have enabled their owner to wade far out to sea in search of seaweeds growing on the ocean-floor; while the armoured kinds, like *Stegosaurus* and *Triceratops*, are considered to have been essentially terrestrial.

As we have indicated, the great bulk of the collection is composed of Secondary reptiles and Tertiary mammals; and from their large size it is these which form its most striking feature. We most not omit to state, however, that it also contains the Toothed Birds from the Cretaceous of Kansas (of which our English collections do not at present possess a single bone), as well as hosts of teeth of Mesozoic mammals, although we have no definite information as to what proportion of these are the property of the State, and what belong to Prof. Marsh. Then, again, scattered among the trays and drawers more especially devoted to the remains of mammals and reptiles is an extensive collection of fish-remains from Cretaceous and Tertiary strata, and especially from the Green River Eocene shales of Wyoming, most of which we believe to be at present totally undescribed.

Space prevents us from saying more as to the extent of this marvellous collection—a collection which, with others from the same regions, has done more in ten years to revolutionize our classifications, and to give us a definite knowledge of many groups of animals previously known by battered fragments, than would have resulted from half a century's work upon European materials. We may, however, conclude by offering our hearty congratulations to the Governments of the United States and to Prof. Marsh, who have succeeded, by the liberality of the one and the untiring energy of the other, in amassing this magnificent collection, which is now, for the first time, in a fair way to be exhibited in a manner befitting its value and importance. Prof. Marsh's magnificently illustrated monographs on the Toothed Birds and the Dinocerata are splendid examples of how a collection like this ought to be made known to the scientific world at large; and we trust ere long to be able to welcome his long-promised volumes on the Dinosaurs and the Brontotheres, which will render its riches yet better known.

R. LYDEKKER.

DYNAMO-ELECTRIC MACHINERY.[1]

THIS is the first part of a treatise dealing with dynamo-electric machinery and its applications, and comprises the theory and practical construction of dynamos and motors, and an account of instruments and methods of electrical measurement. Such subjects as the fusion and welding of metals by electricity and the transmission of power are reserved for a second part, to be issued in the autumn of the present year.

The author begins with a chapter entitled "Generalities regarding Dynamos," in which he discusses the early rudimentary magneto-machines of Pixii and Clarke, and the multipolar machines of the same class invented by Stöhrer and Niaudet, gives a general explanation of the self-excitation and action of series of shunt and compound dynamos, and describes the various typical forms of armature used in constant and alternating-current machines. In this part there is room for little novelty of treatment; the author could only endeavour to be impartially historical and clearly descriptive, and give as complete and useful an account of the more important examples of dynamo machinery as his space would admit of. In this Signor Ferrini seems to have succeeded very well. He does not weary his readers with descriptions of mere antiquities, but supplies only such a brief account of earlier forms as is sufficient to enable the reader to trace the evolution of the modern constant-current dynamo, with its beautiful balance and inter-relation of parts, from the rudimentary, uneconomical, and violently periodic machine of twenty years ago, or to compare the powerful alternator of the present day with the ineffective and wasteful toy instrument, which used to figure in cabinets of apparatus and the older books on electricity.

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[1] "Recenti Progressi nelle Applicazioni dell' Elettricità di Rinaldo Ferrini." Parte Prima: Delle Dinamo. (Milano: Ulrico Hoepli, 1892.)

Chapter ii. deals with magnetic induction, and chapter iii. with the induction of currents by the motion of conductors in a magnetic field. These extend over almost 100 pages, or about one-fourth of the whole volume, a space none too large for the subject, but perhaps a little out of proportion to that devoted to dynamo machinery, which is still further restricted by the allocation of fifty pages in chapter iv. to methods of measurement.

Signor Ferrini's treatment of the theoretical part of his subject seems on the whole marked by completeness and accuracy. He has evidently given careful attention to the late developments of magnetic research, and in his chapter on measurements has included most of the improvements recently made, such, for example, as the methods of measuring power, &c., in the circuits of alternators and transformers which have been invented by Ayrton and others. No mention is made, however, of Blakesley's ingenious "split dynamometer" method for transformers, and determining the difference of phase of two alternating currents. Nor is the method (p. 171) of finding the true mean activity in an alternating current from the apparent activity attributed to its inventor, Prof. Ayrton.

We notice here a few points which have occurred to us in looking over this part of the book as perhaps calling for remark. First of all with respect to the definition of a uniform magnetic field given at p. 58, it may be noticed that if the numerical value of the intensity of the magnetic force be the same at all points of a finite space, its direction must be the same at all points of the same space, and that the intensity cannot vary in magnitude from point to point without varying also in direction, and *vice versâ*. This does not seem to be generally understood, at any rate it is common to define a uniform field as one for which the magnitude *and the direction* of the magnetic force are the same at every point. That the former implies the latter, and the latter the former, may be seen by considering a closed surface formed by a portion of a tube of force, in the field, intercepted between two equipotential surfaces. The cross-sections at the two ends must have the same area, since the magnetic force at each end is the same. Further, the lines must be straight, for if they be supposed curved, the portion of the tube may be taken so that it is concave on one side and convex on the other. The line-integral of magnetic force round a closed circuit, taken along the convex and concave sides and across the ends, vanishes. But nothing is contributed to it by the ends of the tube. Hence the magnetic force along the convex side must be on the whole less than that along the shorter concave side, which contradicts the supposed uniformity of magnitude of the field-intensity.

At p. 66 difference of potential, V_1-V_0, between two points is defined as the work which must be done against magnetic forces in carrying a *unit* magnetic pole from the point of lower to that of higher potential; and at p. 74, where the field of a solenoid is considered, $-dV/dx$ appears as the force on a pole of strength m.

At p. 81 mention might have been made of the influence of mechanical stress and disturbance on the magnetization of iron observed by Lord Kelvin and others, and of the fact that very much higher permeabilities than the 2000 quoted from Rowland's experiments have been obtained by Ewing for soft iron subjected to molecular vibration produced by tapping.

The subject of hysteresis is dealt with at p. 91, and again at p. 235 in the chapter on the construction of a continuous-current dynamo. In the latter place a proof is furnished of the well-known formula given by Warburg in 1881 or 1882, and a little later by Ewing, for the energy dissipated in a closed cycle of magnetization. In the course of that proof, to which in itself we take no exception, one or two statements are made which, if we have understood the author aright, are erroneous. It is stated that when the integral induction Φ through each turn of a magnetizing helix of n windings, each carrying a current c, is increased by an amount $d\Phi$, a quantity of energy $= - ncd\theta$ $(= - v\mathbf{H}d\mathbf{B}/4\pi)$, where v is the volume of the medium magnetized, $\mathbf{H}$ the field intensity and $\mathbf{B}$ the induction, both supposed uniform) is given out by the spiral *and converted into heat*. Now (the sign being left out of account) this is certainly the energy sent into the field from the battery or generator, but it is not the case that it is all converted into heat. The amount of energy spent in unit volume of the magnetized medium is $\mathbf{H}d\mathbf{B}/4\pi$, but of this $(\mathbf{H}d\mathbf{B} + \mathbf{B}d\mathbf{H})/8\pi$ goes to increase the electrokinetic energy, the amount of which per unit volume of the medium is $\mathbf{BH}/8\pi$. The total amount of energy spent per unit volume in the cycle of magnetization, otherwise than in increasing the electrokinetic energy, is therefore

$$\frac{1}{4\pi}\int\left\{\mathbf{H}d\mathbf{B} - \frac{1}{2}(\mathbf{H}d\mathbf{B} + \mathbf{B}d\mathbf{H})\right\},$$

the integrals being taken round the cycle. (It is to be noticed that this balance of energy may be negative, and in that case energy is taken from the field to make up the increase of electrokinetic energy.[1])

But for a closed cycle

$$\int(\mathbf{H}d\mathbf{B} + \mathbf{B}d\mathbf{H}) = 0,$$

and hence the energy spent is

$$\frac{1}{4\pi}\int\mathbf{H}d\mathbf{B}.$$

This must have been dissipated, since the medium at the end of the cycle has returned to the same state as at first.

No affirmation can be made as to what becomes of the balance of energy, except with reference to a closed cycle.

Again, at p. 237 it is stated that if $\mathbf{H}_1$, $-\mathbf{H}_1$, be limits of $\mathbf{H}$ corresponding to limits $\mathbf{B}_1$, $-\mathbf{B}_1$ of $\mathbf{B}$,

$$\int_{-\mathbf{H}_1}^{\mathbf{H}_1}\mathbf{H}d\mathbf{B} = \int_{-\mathbf{B}_1}^{\mathbf{B}_1}\mathbf{B}d\mathbf{H}.$$

This is certainly not correct, as may be easily seen by representing the integrals graphically, or by considering that taken round a closed cycle

$$\int\mathbf{B}d\mathbf{H} = -\int\mathbf{H}d\mathbf{B},$$

since

$$\int(\mathbf{H}d\mathbf{B} + \mathbf{B}d\mathbf{H}) = \int d(\mathbf{BH}) = 0$$

for the cycle.

This error, a mere oversight no doubt, has appeared more than once in connection with this subject, and an erroneous demonstration founded on it and a mistaken identification of the energy dissipated with the electrokinetic energy, has been used by more than one writer.

The chapters on the "Continuous Current Dynamo," the "Dynamo in Action," and "Alternating Dynamos," are excellent in many respects. The subject is well and fairly comprehensively treated, and the very useful notion of the magnetic circuit has been employed throughout with good effect. Some well-known machines do not seem to be described, for example, the Victoria among continuous-current machines, and the latest form of Mordey's alternator.

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[1] See a paper by the writer in the *Phil. Mag.*, December 1890.

The inclusion of a larger number of thoroughly practical examples of dynamo specification and construction would also be an improvement.

On the whole, Signor Ferrini's book seems the outcome of an earnest endeavour to give an accurate and full account in moderate compass of an important and difficult subject. It will be more easy to judge of the full measure of the author's success when the work is completed. In any case the book seems likely to be a credit to Italian technical literature. A. GRAY.

MR. A. NORMAN TATE.

BY the death of Mr. A. Norman Tate, F.I.C., Liverpool has lost one of her most prominent citizens and men of science. It is not only as an able analytical chemist that Mr. Tate will be missed by a large section of the public to whom his genial presence was familiar, but as a scientific teacher and pioneer of the technical education movement in Lancashire, his place is one that will not easily be filled. For some time past Mr. Tate has had indifferent health, and has had to give up much of his active work in connection with the Society of Chemical Industry, of whose Publication Committee he was a member, and the numerous local and other learned societies to which he gave great aid. Latterly, symptoms of an ulcerous tumour in the stomach presented themselves, from which he died on the 22nd instant.

Mr. Norman Tate was a native of Wells, Somerset, and came to Liverpool about thirty-five years ago, when he entered the laboratory of the late Dr. Sheridan Muspratt. He published several papers bearing on his early researches in the journals of the Chemical Society of London and the Royal Dublin Society. After acting for some years as chemist to the firm of John Hutchinson and Co., of Widnes, he commenced practice as an analyst in Liverpool, and became consulting chemist to several important local bodies and chemical manufactories. At that time the importation of petroleum from America was beginning, and on this subject Mr. Tate became an authority; one of his works, "Petroleum and its Products," being translated and re-published in France and Germany. For a time Mr. Tate superintended the working of oil refineries in the Isle of Man and in Flintshire, where he erected a manufactory for the production of coal and shale oils. In 1870, Mr. Tate, in conjunction with Mr. James Samuelson, undertook the initiation of the Liverpool Science and Art Classes, which grew to be a great educational power in the city. As honorary principal, Mr. Tate had charge of these classes, besides giving lectures himself and teaching several of the classes in chemistry, botany, and general biology. He also instituted the Liverpool Science Students' Association, and the Liverpool District Science and Art Teachers' Association, of both of which bodies he was the first president, a post he also filled in the local Geological Association, Microscopical Society, Liverpool Section of the Society of Chemical Industry, and other institutions, contributing largely to their "Transactions." The "Proceedings" of the Liverpool Geological Society also contain many of his papers and memoirs. He discovered the presence of iserine in the decomposed greenstones of the Boulder Clay in the Valley of the Mersey, and showed that the black colour of certain sandstones in the trias in the neighbourhood of Liverpool is due to the grains being coated with peroxide of manganese.

Mr. Tate was an ardent supporter of every educational movement, especially in connection with science teaching, and his death, at the early age of fifty-six, will be much deplored by a circle of friends extending far beyond the limits of the city which he had made the chief scene of his labours. O. W. J.

THE BRITISH ASSOCIATION.

EVERYTHING is now practically ready for the meeting of the British Association, which begins next week, and promises to be in every way most successful. Many distinguished foreign men of science—among them Helmholtz, Cremona, and Sachs—are expected to be present. The arrangements made by the local committee we described last week.

In compliment to the President there will be a specially strong muster of geologists. We hear that a number of professors and others connected with the Geological Survey of France are coming. Baron von Richthofen and Prof. Credner will represent the geologists of Germany; Prof. Renard those of Belgium. There will be many other representatives from different countries in Europe and from America. The geological excursions will likewise form a prominent feature in the proceedings, and one of these is to be conducted by the President of the Association in person. The Prince of Monaco, well known for his scientific researches, intends to bring his deep-sea dredging vessel to Granton, and to read a paper on the results of his marine surveys; while two members of his scientific staff will communicate papers on some of the natural history objects obtained by them. Already a large amount of hospitality has been organized, and the meeting bids fair to be as successful in a social as in a scientific way.

We have already announced that at the meeting of Section A. on Monday, August 8, a discussion on the subject of a national physical laboratory will be opened by Prof. Oliver J. Lodge, F.R.S.

A meeting of the Electrical Standards Committee will be held on Thursday, August 4. It is expected that Dr. von Helmholtz, Dr. Lindeck of the Berlin Reichsanstalt, and others interested in electrical measurements, will be present. A discussion will take place with a view to securing an absolute uniformity in the standards adopted in England and elsewhere. The following points will be considered:—(1) The value of the B.A. unit in ohms; (2) the specific resistance of mercury in ohms; (3) standardizing by the electrolysis of silver; (4) the electromotive force of a Clark cell; (5) Report of the Committee for 1892. It is proposed to take the report of the Committee in Section A. on Tuesday, August 9. The draft prepared by the secretary is formal; but it is hoped that the discussion in the Committee may lead to some resolutions, which will be included in the report.

The proceedings of Section D. promise to be exceptionally interesting. The President's address will relate to some qualities of sensation, with special reference to colour sense. On Friday there will be a joint discussion with B. on chemical aspects of the action of Bacteria, which will probably be opened by Prof. Marshall Ward. On Monday there will be a discussion on some matters connected with sea-fishes and fisheries, in which the following will read short papers or take part:—Sir J. Gibson Maitland, Prof. M'Intosh, Prof. Ewart, Dr. Fulton, Prof. Herdman, Mr. E. Holt, Mr. R. Smith, Mr. G. Brook, &c.

NOTES.

THE summer meeting of the Institution of Mechanical Engineers, to which we referred last week, began at Portsmouth on Tuesday, under the presidency of Dr. William Anderson, F.R.S. The president, council, and members were received by the Mayor, who cordially welcomed them to Portsmouth.

THE British Medical Association's sixtieth annual meeting was opened at Nottingham on Tuesday, the chair being occupied by Dr. W. Withers Moore. In his presidential address Dr. Moore dealt with the progress which has been made in surgery and medicine since 1857, when the Association held its last meeting at Nottingham.

A GENERAL meeting of the Sanitary Inspectors' Association was held at Carpenters' Hall, London Wall, on Saturday evening last, the president, Dr. B. W. Richardson, presiding. The council presented a report upon the question of examination for sanitary inspectors, recommending that they should be empowered to confer with the court of the Carpenters' Company in order to arrange for lectures and examinations. The report was adopted. A report upon the association's recent visit to Paris was also presented, setting forth the principal features and incidents of the journey. The adoption of this report was moved by Mr. Alexander, and seconded by Mr. Tidman. The chairman, in supporting the motion, said the association had learned many important lessons upon the question of sanitation by their visit to the French capital. After comparing the French and English systems of sanitation, he expressed the opinion that in the matter of disinfection the English might learn much from their French neighbours. He believed that in London there might with advantage be established one or more grand centres for disinfection such as existed in Paris. He deprecated the system in use at the Paris Morgue of freezing dead bodies for the purpose of identification as being, in his belief, utterly useless for that purpose. On the question of the inspection of animal food, he thought that England could not do better than follow the system adopted in France of testing every doubtful animal before it went to the shambles. A discussion followed, and on the motion of the chairman an ambulance committee was formed to report on the ambulance system in London. The report was adopted.

AN official telegram received at the Hague from Batavia confirms to some extent the statement made at Sydney as to a terrible volcanic eruption in the island of Great Sangir. The volcano which caused the disaster is named Gunona Awu. The telegram adds that the whole of the north-western portion of the island was entirely destroyed, 2,000 persons being killed. The victims included no Europeans. The rest of the island has also suffered seriously by the eruption, but it is hoped that the damage may be repaired in the course of six months. The crops have been destroyed.

FOR some days the eruption of Mount Etna seemed to be gradually decreasing, but on Tuesday it was again very violent, and there were loud subterranean noises. On Monday evening there was a shock of earthquake at Mineo, thirty-seven miles to the south of the volcano. A correspondent of the *Times*, writing from Catania on July 18, says that the exact seat of the eruption cannot be discovered from that city on account of the dense masses of smoke with which that side of the mountain is enveloped, but from Augusta, a town situated about 15 miles away, the summit and western outline are to be seen standing out in bold prominence against the deep, gentian-blue of the Mediterranean sky, and, with its endless volumes of steam and smoke rolling away to the eastward, Etna presents an indescribably imposing, not to say majestic, appearance. From this little town the scene is sublime.

THE cause of the terrible disaster at St. Gervais is now being investigated by several men of science. There can be no doubt that it originated in the small glacier called the TêteRousse, which is nearly 10,000 feet above sea-level. According to a correspondent of the *Times*, who writes from Lucerne, Prof. Duparc is of opinion that the habitual drainage of this glacier had for some reason or other become either totally blocked or obstructed; the water gradually accumulated in its natural concavity or bed; and the ever-increasing volume had exercised such an enormous pressure as to force a passage and carry away a portion of the face of the glacier with it. The mass of ice and water rushed down the rocks which dominate the glacier of Bionnassay, not in a single stream but in several, and then reunited into one enormous torrent at the foot of the Bionnassay glacier. A different theory is held by Prof. Forel, of which the correspondent of the *Times* gives the following account:—Professor Forel does not see how a quantity of water sufficient to force away so large a portion of the glacier could possibly accumulate in so small a body as the Tête Rousse, which has a total superficies of less than one hundred acres. It slopes freely on three sides; it is, in fact, one of the most abrupt of the whole chain of Mont Blanc; and, in a glacier of this description, with an altitude of nearly 10,000 ft., there are none of the conditions of a great accumulation of water. In his opinion, therefore, we must look for the main cause of the disaster in the natural movement and breaking up of the glacier. He estimates the volume of ice which fell at between one and two million cubic metres. The mass, first in falling and then rushing down the rapid slope, became transformed, for the most part, into what he calls a lava of ice and water. The ravine, he says, through which this avalanche rushed shows no traces of any great evacuation of water; in the upper portions of its transit there is no mud and no accumulation of sand, but, on the other hand, there are great blocks of glacier ice strewn everywhere, and at several points he found portions of powdered ice mixed with earth. Then, again, if this had been simply a torrent of water falling, it would have found its way down the more violent inclines, instead of, as in this case, passing straight over the frontal moraine at the foot of the glacier. In this higher region, therefore, all the evidence points to an avalanche of ice, which, starting at an altitude of nearly 10,000 ft., and descending at an incline of 70 per cent. for 5,000 ft., was pulverized by its fall, a large portion of it being melted by the heat generated in its rapid passage and contact with matters relatively warm. It rushed into the ravine by the side of the glacier of Bionnassay and joined the waters of the torrent which issues therefrom, and, further aided by the stream of Bon Nant, it became sufficiently liquid to travel down the lower portions of the valley at the slighter incline of 10 per cent., and yet retained sufficient consistency to destroy everything in its passage. That this torrent was not composed merely of mud and water is proved, he says, by the fact that it did not always maintain the same height when confined to the narrower ravine, and that the remains on the sides of the rock show it to have been a viscous substance rather than fluid.

AN entire change of weather set in over these islands during the past week. The severe storm referred to in our last issue passed quickly to the south-eastward across the Channel, and subsequently traversed Switzerland and Italy. This was succeeded by an area of high barometer readings, which reached this country from off the Atlantic, and extended eastwards over a great part of Europe. Anticyclonic conditions have since been very persistent, with an unusual amount of cloud, especially in the north and south, and, occasionally, mist or fog, but the weather was otherwise fine and very dry. Temperature remained low, under the influence of northerly and easterly winds, the maxima seldom exceeding 70°, while the night minima have also been low, especially over the inland districts of England, where, in places, readings have fallen to within 10° of the freezing point.

THE Vatican Observatory, recently established by Pope Leo XIII., has issued volume ii. of its "Pubblicazioni," containing the results of the most important researches undertaken at the observatory, together with a summary of the proceedings of the meetings held in the year 1891, which comprise a collection of notices relating to astronomy and terrestrial physics. Prof. J. Buti contributes papers (1) on the variations of temperature at different heights. The maxima were generally highest at the lower station, especially in spring and summer, while in winter the conditions were reversed. The mimima were higher throughout the year at the higher station than those near the ground. These results are in accordance with those obtained by the director, Padre Denza, in the case of observations taken at Turin. (2) On rainfall at different heights. The results show that the amount of rainfall is greater at the higher station at times of heavy rain, and conversely at times of slight rain. (3) Comparisons of relative humidity, tension of vapour, and temperature, accompanied by curves. The work also contains hourly observations from January to June, photograms of lunar regions, phototypes of some constellations and nebulæ.

AS an illustration of the specialization of scientific teaching on the Continent, we may mention that Dr. H. Schinz has been appointed Professor of Systematic Botany at the University of Zürich, in order that Prof. A. Dodel may devote his course of lectures entirely to Anatomical and Physiological Botany.

GENERAL PARIS, of Dinard (Ille-et-Vilaine, France), is engaged in the preparation of a *Nomenclator Bryologicus*, on the plan of Steudel's "Nomenclator Botanicus." He will be greatly obliged if bryologists of all countries will send him copies of recent memoirs, or an exact reference to the description of all new species, accompanied, where possible, by a specimen.

A NEW botanical publication has made its appearance under the title *Arbeiten aus dem K. Botanischen Garten zu Breslau.* It is edited by Prof. Prantl and will be devoted to the record of work done in the Botanic Garden at Breslau. The first number contains a paper by Prof. Prantl, on the Classification of Ferns, one by Herr Pomrencke on the structure of the wood of certain gamopetalous families, and one by Herr Mez on the Lauraceæ.

IN addition to the Vascular Cryptogams collected under the auspices of the West India Exploration Committee by Mr. R. V. Sherring, F.L.S., in the island, and described in the *Annals of Botany*, Vol. vi., No. 21, April, 1892, by Mr. J. G. Baker, F.R.S., his collections at Kew have yielded about thirty species of Orchids from Grenada, some of which are of considerable interest. They have now been determined by Mr. R. A. Rolfe, A.L.S. The orchids of Grenada appear not to have been systematically collected before. There are no records of species from that island in Grisebach's *Flora of the British West India Islands*, 1864, and only about three or four were represented in the Kew Herbarium. Mr. Sherring's collections, therefore, enable us to arrive at a tolerably good idea of the distribution of orchids in the island. A species of *Brachionidium*, a genus not hitherto represented in the West Indian flora, is probably new, as also species of *Scaphyglottis* and *Cranichis*. *Hexisia reflexa*, *Pleurothallis pruinosa*, *Oncidium luridum* and *Ornithocephalus gladiatus* have not hitherto been found in the smaller islands, the recorded specimens being chiefly from Jamaica and Trinidad. *Dichœa hystricina* has not been found before except in Cuba by Wright and Eggers. *Xylobium* (*Maxillaria pallidiflora*) was recorded before only from St. Vincent, and *Elleanthus lepidus* is new to the West Indian flora. The remaining species are found in many islands, such as Jamaica and Dominica, but their occurrence still further south is a point of some interest.

THE City and Guilds of London Institute has issued a list of the candidates who have passed its examination for the teacher's certificate in manual training. The examination is limited to teachers in public elementary schools. It was held this year for the first time, and related to woodwork. As a large number of teachers had been receiving manual instruction before the institution of the examination, a limited number of candidates were allowed to present themselves for the final examination without having passed the first year's examination. There were 275 candidates for the first year's examination, and of these forty-seven passed in the first class, 108 in the second, and 120 failed. For the final examination there were 340 candidates, of whom forty-nine passed in the first class, 146 passed in the second class, while 145 failed. The examiners report, as regards the first year's examination, that the practical wood-working was uniformly well done, but that the drawing was badly done by a large number of candidates. "It is obvious," they add, "that the instruction in practical drawing is not good. Many candidates failed even to understand the examination paper." In the advanced examination the drawing was much better.

THE Yorkshire College, Leeds, has issued the first report of its department of Agriculture. We are glad to note that the County Lectures to farmers have, as a whole, been successful beyond the most sanguine anticipations of the committee. The unsympathetic attitude which the farmers at some of the centres assumed at first with respect to these lectures was often speedily changed to warm appreciation, which rose, in certain cases, to enthusiasm. The attendance, which was sometimes small at the beginning, grew larger and larger as the course proceeded, and although it afterwards fluctuated for various reasons, the chief of which was the unfavourable state of the weather, which in sparsely populated districts made a journey to the lecture a matter of considerable time and difficulty, the average attendance was extraordinarily good. To the classes and practical demonstrations, which followed many of the lectures, a considerable portion of the audience remained, and their eager participation in the discussions and tests, which formed a conspicuous part of the work of these classes, was extremely encouraging to the lecturers.

AT a meeting of the London Chamber of Commerce on Monday, Mr. J. Ferguson read a paper on "The Production and Consumption of Tea, Coffee, Cacao (cocoa), Cinchona, Cocoanuts and Oil, and Cinnamon, with reference to Tropical Agriculture in Ceylon." He referred to the position of Ceylon, its forcing climate, its command of free cheap labour, and its immunity from the hurricanes which periodically devastated Mauritius, from the cyclones of the Bay of Bengal, and from the volcanic disturbances affecting Java and the Eastern Archipelago. The plantations of Ceylon afforded, he said, the best training in the world for young men in the cultivation and preparation of tropical products, and in the management of free coloured labour. The cultivation of cane sugar, although tried at considerable outlay on several plantations forty and fifty years ago, proved a failure. More recently experiments by European planters with tobacco had not been a success, nothwithstanding that the natives grew a good deal of a coarse quality for their own use. Although cotton growing had not been successful, the island had proved a most congenial home for many useful palms, more particularly the coconut (spelt without the "a" to distinguish it and its products from cocoa—the beans of the shrub Theobroma cacao) and palmyra, as also the areca and kitul or jaggery palms. Within the past few years Ceylon had come to the front as one of the three great tea-producing countries in the world, India and China being the other two, with Java at a respectable distance. Mr. Ferguson said one of the chief objects of his pape was to demonstrate which of the products of the island it was safe to recommend for extended cultivation in new lands and which were already in danger of being over-produced, and he had arrived at the conclusion that coffee, cacao, and rubber-yielding trees were the products to plant, while tea, cinnamon, cardamoms, cinchona bark, pepper, and even palms (for their oil) did not offer encouragement to extended cultivation. Statistics relating to the total production and consumption were given in an appendix.

AN interesting paper on Indian types of beauty was read some time ago by Mr. R. W. Shufeldt, before the Philosophical Society of Washington, and has now been issued as a pamphlet. It is admirably illustrated.

MR. A. G. HOWES, British Consul at Tahiti, in his latest annual report to the Foreign Office, has the following note respecting pearl-shell diving in Tahiti:—Since the introduction of the diver's dress and apparatus at the pearl fisheries in 1890 a considerable increase in the export of shell has been maintained over the previous years. A strong feeling has, however, been exhibited by the natives, who adhere to their own system of diving, against this means of taking the shell, and has resulted in a communication being made by the Director of the Interior of the colony to the Chamber of Commerce at this place, recommending the gradual abolition of the diving dress and apparatus and the stoppage of further issue of patents for the same, from January 1, 1893. The Chamber of Commerce have expressed their approval of the suggestion, but consider that an entire and not gradual abolition of the diving dress and apparatus should take place, and they have decided to lay this proposal before the Conseil-Général when it assembles next August. The reasons set forth by the Chamber of Commerce for adopting this course are that the regulations for the use of the diving dress and apparatus have been abused. They state that French citizens, contrary to rule, have under their name employed diving dress and apparatus owned by foreigners; that the law prohibiting pearl fishing by this means in a depth of less than ten fathoms had not been adhered to, and they also give as their opinion that the shells found in a greater depth than ten fathoms are those mostly important for reproduction, and to destroy them will ruin the fisheries and bring distress upon the natives who depend upon the pearl-shell diving for their livelihood.

THE additions to the Zoological Society's Gardens during the past week include a Common Marmoset (*Hapale jacchus*) from South-east Brazil, presented by Mr. Gerald F. Youll; an African Civet Cat (*Viverra civetta*), a white-tailed Ichneumon (*Herpestes albicauda*), two Ostriches (*Struthio camelus* ♀ ♀) from East Africa, presented by Mr. F. Pardage; a Pine Marten (*Mustela martes*), British, presented by Mr. Harold Hanauer, F.Z.S.; three North American Turkeys (*Meleagris gallo-pavo*) from North America, presented by Col. H. W. Feilden, C.M.Z.S.; two Rufous-necked Wood Doves (*Haplopelia larvata*) from South Africa, presented by Mr. W. H. Wormald; a Grand Eclectus (*Eclectus roratus*) from Moluccas, presented by Messrs. Chas. and Walter Seton; two Red-crested Cardinals (*Paroaria cucullata*) from South America, presented by Miss Edith M. Fox; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mast. S. E. Thorns; a Large Brown Flying Squirrel (*Pteromys oral*) from the Shevaroy Hills, South India, three American Bisons (*Bison americanus* ♀ ♀ ♀) from North America, a Barraband's Parrakeet (*Polytelis barrabandi*) from New South Wales, deposited; a Mongoose Lemur (*Lemur mongoz*) from Madagascar, purchased; an American Bison (*Bison americanus* ♀) from North America, received in exchange.

OUR ASTRONOMICAL COLUMN.

MADRAS OBSERVATORY.—This year being the centenary of the founding of the Madras Observatory, the officiating astronomer, Mr. C. Michie Smith, prefaces his report with a brief historical sketch. It seems that the East India Company were the first to propose the establishment of such an Observatory, but Sir Charles Oakeley, taking time by the forelock, and, as we are informed, anticipating the orders from the India Office, set about constructing it on his own authority. With the aid of Mr. William Petrie, who placed his own observatory at their disposal, the scheme was soon brought to a practical head, and by the time the orders arrived in 1792 the Observatory, besides being actually built, contained many instruments. The first astronomer was Mr. J. Goldingham. Mr. Thomas Glanville Taylor, F.R.S., was Director of the Observatory from 1830 to 1848. After erecting new instruments, he began his catalogue of 11,000 stars, publishing it in the year 1844. Hourly meteorological and magnetic observations were also carried on by him. He died in England in May 1848, having never completely recovered from a serious injury caused by a fall. In 1849 Captain W. S. Jacob was appointed astronomer; he made a new departure in the form of extra-meridional observations. Owing to ill-health Captain Jacob resigned his appointment in 1859, and during the next two years the office was held partly by Major W. K. Worster, R.A., and Major (now General) J. F. Tennant, R.E. About this time the work of the observatory was delayed, as more modern instruments were being erected, and it was not till May 1862 that the new transit circle of 5 inches aperture and 42-inch circle was ready for use. The late Mr. N. R. Pogson, who had then arrived in Madras as Government Astronomer, commenced his catalogue of 5,000 stars, observing each at least 5 times. He also used very considerably the 8-inch equatorial. The present astronomer, Mr. C. Michie Smith, in his report, suggests a further increase of the observatory equipment.

OXFORD UNIVERSITY OBSERVATORY.—During last month the seventeenth annual report of the Savilian Professor of Astronomy was presented to the Board of Visitors of the University Observatory. This report showed that the work of the Observatory during the past year has been very considerable. The Grubb equatorial, the transit circle, and the De la Rue equatorial have been severally occupied, while the new micrometer for the Grubb instrument has worked efficiently, and forms a valuable addition to the resources of the Observatory. The work upon the international chart has formed one of the important features throughout the year, and for the measurement of the photographic plates a new and costly form of micrometer had to be devised; the réseaux have not proved to be very enduring, so that in consequence a new one had to be obtained from Messrs. Gautier of Paris. The work connected with stellar parallax has now been completed after a period of four years' hard work, and this fact deserves the highest consideration in face of the magnitude of the staff and the amount of work done. The manuscript consists of (1) the concise but complete history of all effective researches in stellar parallax up to the present date; (2) the results of the parallax work completed in this Observatory, extending on the whole to some thirty stars; (3) a catalogue of all parallactic determinations effected by other astronomers. Among some of the other work commenced or completed during the present year we may mention the photometric catalogues of stars of the ninth and eleventh magnitudes within small specified areas for the eighteen Observatories engaged in the international chart, observations of Nova Aurigæ, and the investigation of the amount of light "lost by the moon at the commencement and termination of the lunar total eclipse on November 15, 1891." The finances of the Observatory at present, owing to previous economy, seem to cover the expenditure, but Prof. Pritchard seems to refer to the fact that the quinquennial grant expires at the end of the present year, as if next year the University will be called upon to make a slight additional increase to counterbalance the cost of the instrumental equipment that has been required for the chart work. We are glad to note that at this meeting of the Board Prof. Pritchard was able to attend, having completely recovered from his illness.

GEOGRAPHICAL NOTES.

M. DYBOWSKI has returned to France in bad health. His last work in the French Congo territory was an expedition up the Ubangi to avenge the murder of M. Crampel.

THE Royal Belgian Society of Geography has of late been devoting special attention to home affairs, and in particular to the publication of more or less exhaustive monographs of the local geography of the communes. The last number of their *Bulletin* contains an able summary of the geography of the commune of Familleureux, under the main heads of physical, economic, administrative geography and history, with carefully planned subdivisions. By multiplying such studies, the material for a really exhaustive geography of the country will be obtained. Some such scheme might well be applied to the United Kingdom, where a series of county geographies on a definite system and rigorously edited would be peculiarly advantageous. The idea was present in Sir John Sinclair's famous "Statistical Account," but has had no recent or adequate embodiment.

THE *Scottish Geographical Magazine* for July contains a translation by Mr. C. E. D. Black of M. Dauvergne's recent journey in the Pamirs, the original paper appearing simultaneously in the *Bulletin* of the Paris Geographical Society. The journey carried out in 1889-90 was a most successful one and opened up some new ground. The geographical results are summed up in four sentences:—(1) That there is another great chain running parallel to the Kuen Lun and facing Kashgaria. (2) That the river in the Tung valley is an affluent of the Zarafshan, not of the Taghdumbash. (3) That the Oxus rises in the great glaciers of the Hindu Kush at 37° 10' N. and 75° E. (4) That the Karambar valley, although difficult, is practicable for ponies.

DR. THEODOR MENKE, one of the best known of German historical geographers, died in Gotha in May last. His work in the compilation of atlases of historical geography was exceptionally thorough. His first work in this direction was a popular school atlas of classical geography, entitled "Orbis Antiqui Descriptio"; but his most important contribution to cartography was his edition of Spruner's great historical atlas, begun in 1858 and completed in 1879.

DR. STUHLMANN, according to a telegraphic report in the *Times*, has furnished additional particulars of Emin Pasha's expedition, although no more recent news. The real and only aim of Emin's journey to the Equatorial province, was to rescue those of his former subordinates, whose vacillation and delays kept them from joining Stanley's march to the coast. It was then his purpose to make his way across Africa to Adamawa and the Cameroons, a purpose which, as we already know, he had to abandon. It is satisfactory to learn that Dr. Stuhlmann had with him at Bukoba all the valuable scientific records and collections of the expedition.

THE current number of *Petermann's Mitteilungen* calls attention to a curious literary fraud to which in the two previous numbers it fell a victim, and from which many geographical journals in the habit of faithfully reproducing the articles of *Petermann* also suffer. A Dr. Ceyp professed to have made a journey recently in south-eastern Persia, and communicated to *Petermann* a detailed account of it, which now appears to have been copied verbatim from a little-known work, "Gasteiger-Khans," reprinted from the "Boten für Tirol und Vorarlberg," 1881. General Houtum Schindler, of Teheran, who knew that Ceyp's Persian travels had not led him beyond that city, gave the information which led to this discovery. The episode furnishes a fresh proof of the necessity for the great caution in accepting the records of unknown travellers which has always been exercised by the leading English authorities.

THE BEARING OF PATHOLOGY UPON THE DOCTRINE OF THE TRANSMISSION OF ACQUIRED CHARACTERS.

FOR more than two years the English public has been in possession of an excellent translation of sundry of Weismann's more important essays.[1] The object of this paper is not to expound Weissmann's views generally. That office has already been undertaken by the persons best qualified to perform it.[2] We propose merely to discuss one of his topics under a single aspect—the "Transmission of Acquired Characters" in its relations to pathology.

We cannot, however, avoid reviewing some of the leading points in Weismann's system which bear upon our immediate topic.

At the root of the matter lies the all-important distinction between reproductive and somatic cells. Saving among the lowest forms of animal life, an organism may be regarded as made up of two parts. There are the reproductive cells. With these the future of the species lies. They are the visible basis of its perpetuity. The remaining tissues of the body are styled "somatic." It is natural to us to think of the "somatic" tissues as something higher and nobler than the reproductive cells—to contrast the simplicity of the latter in structure and endowment with the intricacy of the former. But there is another point of view, which inverts matters; which regards the somatic tissues—the body and its manifold endowments—simply as a sort of living case or appendage of the reproductive cells. The reproductive cells look after the perpetuity of the species, the somatic cells look after the reproductive cells.

Now, if we travel back to the simplest forms of animal life, we lose sight of this distinction. The principle of differentiation of labour is not yet recognized. Among the Protozoa the distinction between reproductive and somatic cells has no place. Every part of the organism has it in its power to reproduce the entire organism. No special material is reserved to serve the purposes of reproduction. As we ascend in the scale of animal life, differentiation of labour begins. There is from the outset a reservation of reproductive cells, which serve as the demonstrable links between successive generations of organisms. But in sundry of the highest forms of animal life a third condition obtains. There is at the outset no reservation of cells: differentiation overtakes the entire organism—there is no exemption.

Not till the close of embryonic life do the reproductive cells appear, and when they do so it is as the offspring of somatic cells. This third condition was felt by Weismann as a difficulty, and led to an important modification in his terminology. The problem he had to explain was this, How can cells which have apparently lost their reproductive characters afterwards regain them? The solution he found was that the differentiation undergone by certain cells was never in reality thoroughgoing enough to deprive them of their original characters. Sooner or later, a moment arrives at which the original "germ-plasm" becomes again predominant. Instead, then, of in "germ-cells," the basis of perpetuity of the species is laid in "germ-plasm."[1]

We have now to consider the bearing of these views upon the doctrine of the transmission of acquired characters.

It is of the utmost importance to understand precisely what Weismann means by the term "acquired character." Acquired characters are opposed to original characters. To grasp the distinction we are sent back to a time before the distinction between reproductive and somatic cells existed. The characters already present at this early period are original characters. Later on, the reproductive and somatic cells part company, to follow separate careers of their own. It is the somatic cells—the body—which comes chiefly into collision with the environment, and in doing so undergoes various modifications. Now these modifications are the "acquired characters" the transmissibility of which Weismann denies.

They may be something purely local, as a scar or a mutilation. They may be something which involves the modification of complex musculo-nervous mechanisms, as in delicate manipulations and tricks of skill, such as violin-playing. Now, how is it conceivable, he argues, that such specific changes in the somatic tissues should influence the reproductive cells in the same direction? Whether they influence them at all is not the matter in dispute. That they do this is not only conceivable, but highly probable. But how can the somatic cells stamp their own special characters upon the reproductive cells?

We now turn to the main topic of this paper. Has pathology anything to say, either for or against, the transmissibility of acquired characters?

Now, as to the transmissibility of sundry forms of disease there is no question. That pathological characters are transmitted is universally allowed. The difficulty, however, is to decide whether such characters were really acquired, in the strict sense in which Weismann uses the term. We shall find that it will require considerable care to adduce instances which are really appropriate. With this preliminary caution we may proceed to attempt some sort of preliminary classification of our pathological data. We shall find that they fall, roughly, into three main groups:—

(1) Morbid characters which are obviously acquired by the organism, and as obviously transmitted. But since they are in no sense the acquisition of the somatic cells as such, but of the entire organism—somatic and reproductive cells alike—they cannot be allowed to "rank."

(2) Morbid characters in which an element of transmission is obvious, but where a closer investigation reveals the fact that, supposing them to have been acquired, in Weismann's sense of

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[1] Translation edited by E. B. Poulton, Schönland, and Shipley.

[2] Prof. Moseley's two articles in NATURE, vols. xxxiii. and xxxiv. Discussion introduced by Prof. Lankester at the meeting of the British Association, 1887.

[1] See Weismann's essay on "Foundation of a Theory of Heredity," *passim*.

the word, it is not precisely what was acquired that is transmitted, but something broader and more general.

(3) The cases which are really in point: morbid characters which were really acquired by the somatic tissues alone. We shall see, later, whether or no these are transmitted.

(1) This group embraces all those cases in which a morbid character is acquired by the entire organism, somatic and reproductive cells alike. Behind the distinction between somatic and reproductive cells lies the fact of a common relation to the circulatory and nervous systems. Any change, therefore, in the circulation for example, will affect both. A pregnant woman takes a fever, and transmits it there and then to her offspring. There is no more mystery in this than in the fact that certain poisons produce abortion—indeed, the *materies morbi* is a poison in either case. But this explanation has, in all probability, a much wider range than the zymotic diseases. Consider, for example, gout. In a sense it is no doubt true to say that gout was an acquired disease. We can point to periods in the world's history in which gout was conspicuous by its absence. We can trace with some degree of accuracy its rise and progress at different epochs, and point to the conditions under which it rose, as, for example, in the early days of the Roman Empire.[1]

But even if we allow that gout was, in a general sense, an acquisition of civilized society, we have only to reflect on its pathology to see that it could never have been acquired in Weismann's sense. For what is gout? People usually think of gout by one of its manifestations—inflammation. This, however, is in reality no more than a symptom—perhaps than an incident—of a condition. The gouty attack is due to the existence of certain sites in the system conveniently cool and dry for the deposition of what are popularly known as chalk stones, if, indeed, it be correct to think of the morbid process as a deposition. The general morbid condition lies deeper, and still eludes us. But if we are in the dark as to the precise nature of the pathology of gout, it would be affectation to say that we are unable to prescribe its general outlines. Is it a degeneration, in which the entire organism shares? Then it will be a morbid acquisition of both somatic and reproductive cells alike. Or is it a failure in metabolism generally? The same will be the case. Or is it due to a failure in some particular gland to elaborate the materials brought to it, or to do its share of excretion? If so, the mischief will immediately make itself felt in the circulation, and the conditions of the sufferer will become practically those of slow self-poisoning. So that on no hypothesis can we represent gout as an acquisition of the somatic cells exclusively.

It is the element of progressive heredity which makes the hypothesis of transmission of acquired characters an attractive one in a disease like gout. This element is, in the case of certain families, strongly marked. We even see children suffering from the disease. And bearing in mind what we know of its ætiology, we naturally say to ourselves, "It was not this child's fault that he was born gouty. 'The fathers must have eaten the sour grapes,' or in this case, perhaps, have drunk the sweet ones." But it needs but a moment's reflection to convince us that the element of progressive heredity, so far from being an anomaly, is deducible from the facts of the case. It is true that here we cannot directly apply the theory of natural selection. We are not now concerned with conditions of progress, but with those of regress. Nature selects the fittest. There is no reason why she should select the goutiest. The question we have to ask in disease is not whether Nature selects, but whether she summarily rejects. If she stepped in and exterminated the gouty, she would stop gout altogether, and with it the feature of progressive heredity. But there is no reason to suppose that, as a fact, she does anything of the kind. In the first place, gout is not a disease which seriously shortens life; in an advanced stage of civilization its existence is quite consistent, not merely with life, but with the active discharge of elaborate duties.

But there is another more important consideration. Strange as it may sound, there may be good reasons for supposing that Nature, so far from rejecting, might even select, the goutiest. For gout, like other diseases, is only one corner of a much wider question. Diseases have coincidents and relations which stretch beyond the bounds of pathology, and trespass upon biology. This, indeed, is a side of clinical study which has only comparatively recently received its proper recognition. In former days men contented themselves with observing the morbid symptoms of a gouty patient; they paid no regard to his other "points"—his nails, his teeth, his intellectual endowments. But it may often happen that morbid characters have their good affinities. This is probably the case in gout. We have heard it said, for example, by one of wide experience in this disease, "No gouty person is a fool"—a statement which derives some support from the number of eminent men who have been the subjects of this disease. It is often implied that in what is termed an "artificial" civilization natural selection ceases. Might we not, perhaps, say that it still proceeds, only upon a modified plan. The conditions of the competition for existence have altered. The fittest in one generation need not be the fittest of another. Thus, in a rude state of society, in which sustained physical strength is the one thing needful, the gouty man would have no chance. His enemies, however inferior they might be, would have nothing to do but to lay by for the next attack of gout, when they would easily kill him. In a more advanced state of society all this is changed. If the gouty man has talents, he probably has friends and money. There is no demand for sustained physical strength. If he has the gout he can be nursed. His gout may be even of advantage to him—he gets into the papers. So that, paradoxical as it may seem, Nature may even select the gouty, not for their gout, but for their biological equivalents.

We have shown then that Nature, so far from interfering to exterminate the gouty, might even select them. But a more plain and obvious reason exists for the progressiveness which we sometimes observe in gout. If gout be a modification of the system generally, if its progressive increase in the tissues of a gouty patient with increasing years is in some cases a matter of observation, it would only be reasonable to infer that the same is true of the reproductive cells. For, if they share in the degeneracy, why should they not share in the progressive tendency? In the light of this consideration we can explain a fact widely received among medical men—that the incidence of a gouty inheritance falls mainly upon the younger children. Since the reproductive cells as well as the somatic grow goutier and goutier as age advances, the later their separation occurs the more likely will they be to manifest gout.

(2) The second group includes cases in which there is an undoubted transmission of morbid characters, but where it is by no means certain that they were "acquired" in the sense under discussion. But even if they were, it does not seem that what was acquired is transmitted, but something broader, and more general. We shall take as examples two important diseases—phthisis and "new growths"—alluding briefly to the phenomena of "short sight."

Phthisis may be said to be in one sense, like gout, a disease acquired by civilized humanity. "The naked savage," writes Dr. Andrew in 1884,[2] "whatever ills he may have to bear, rarely reckons phthisis among them; with every addition to his clothing and the comfort of his tree or cave, proclivity to it increases,"—a statement which is fully borne out by what we know of the spread of phthisis in the Rocky Mountains and the islands of the Pacific. If we know less of the history of the rise and spread of phthisis than we do of gout, we have more definite conceptions regarding its pathology. At the present day that pathology may be said to have two sides. There is the side originated and elaborated by Koch—the demonstration of the constant presence of a vegetable parasite in the tissues in this disease. There is the chemico-physiological side. Before Pasteur's time, such terms as "medium," "soil," as applied to the human organism, were little more than metaphors, while such words as "constitution," "predisposition," had little more than a metaphysical value. At present, scores of workers are busily engaged in translating these terms from the language of metaphysics into their chemical and biological equivalents.

If, then, phthisis was originally acquired, what was it that was acquired? It would seem that we can take our choice between saying that the microbe was acquired, or a habit of body favouring its growth. Supposing, then, the acquisition to have been no more than the lodgment of a parasite in the tissues, can we suppose that it is the parasite which is transmitted? Our facts will hardly warrant such an assumption. How, for example, could we interpret such familiar incidents as the following? A mother, after giving birth to several children, who successively fall victims to phthisis in young adult life, is ultimately attacked herself by the same disease, at a date removed by an interval of several years from the birth of the last phthisical child. Here we should be driven to assume, not in the case of the mother alone, but in each of the several children, a long latent period, during which the parasites, though present in the tissues, made no sign. Such an assumption presents great difficulties. Again, the direct transmission of tuberculosis from a mother to her fœtus is admittedly rare, whereas on the supposed hypothesis we should expect to find it common.[1]

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[1] Pliny, "Hist. Nat.," lib. xxvi. cap. lxiv., ed. Franzius. Senecæ Opera, F. Haase (Lips., 1886), Epistul. Mor., lib. xv., Ep. 3 (95). Galen, "Comment. in Hipp. Aphorism," cap. xxviii., ed. Kühn, xviii. A. 42.

[1] *Brit. Med. Journ.*, 1884, 707

But if it is not the parasite that is transmitted, what *is* transmitted? We are driven back on the "other side" of the pathology of phthisis. But if we suppose that the transmission is not one of a parasite, but of a "diathesis," or "predisposition," then we desert the only standpoint from which there is any chance of proving that the disease was acquired in the sense under discussion. For what reasonable ground could we have for restricting this "predisposition" to the somatic cells alone, to the exclusion of the reproductive cells?

On the hypothesis that the thing transmitted is a "predisposition," we can, as in gout, explain the element of progressive heredity in phthisis. For, the admission of a morbid change once made, the difficulty is not so much to explain its progression as its arrest. In certain consumptive families we have in the limits of a single generation this morbid progress going on under our very eyes. It is the rule to find in such families, where several brothers and sisters are attacked, the younger fall victims at an earlier age than the elder, showing in this way their increasing liability. The explanation is probably identical with the one suggested in gout. The entire organism of the parent becomes more and more phthisically disposed—somatic and reproductive cells alike. The later the separation of the latter occurs, the more likely will they be to manifest phthisis.

The same line of argument is applicable to the facts of "short sight."[2] Short-sightedness is certainly hereditary—it runs in families—but that does not prove that we have in it an example of the transmission of acquired characters. For in the first place it would be very difficult to prove that the short sight was in the first instance acquired in the sense under discussion. While the progressiveness of the morbid character—which seems to support the theory—can be as well explained without it. For if there is no proof that the morbid character—the faulty build of the eye—is itself progressive, there is good reason to suppose that the habits of close attention which minister to the defect are so. In one generation we find a man simply tasking his eyes; his son works with a simple microscope; his grandson with an improved microscope.

I pass on to consider another group of pathological facts, of the highest importance and interest—new growths. The element of heredity doubtless obtains here as in the case of gout and phthisis. Thus the statistics of Sir J. Paget in this island, and those of Velpeau on the Continent, agree in showing that heredity can be traced in about one-third of the entire cases of cancer.[3] And among the benign tumours, as they are called, warts and exostoses are hereditary. Further, there is in some cases evidence of progressive heredity, the irregularity appearing in the children at an earlier age than it appeared previously in the parent. And we have here what might look at first sight more like a real transmission of acquired characters than anything we have yet dealt with. No one questions that something is transmitted. The theory of the local origin of the new growths is gaining ground everywhere, and might appear to carry the inference that they are acquired, and that no constitutional element is involved in them. Here, however, we must be on our guard against the fallaciousness of words. If by constitutional we mean something pervading the entire organism—a taint in the blood, and so forth—then there is little or no evidence to warrant our calling new growths constitutional. But if we mean, on the other hand, something which was represented in the original germ—an error in the original plan, not a supervening flaw—then there is nothing to encourage us in denying, and a good deal to warrant our asserting, their constitutional origin. However, such an admission is not necessary to our present purpose. Let us assume that they are acquired in the sense in which a scar is acquired. Is it a fact that what is acquired is transmitted? If so, we should look for identity in position and histological character in the thing transmitted. But on the whole neither of these conditions is fulfilled. Certainly they are not, in the case of cancer, as the analysis by Mr. Morrant Baker[1] of 103 of Sir J. Paget's cases clearly shows. The distribution of the cancers proper shows a variation within certain limits. There is a strong predilection for certain sites, but these sites are sufficiently numerous. Now, it often happens that, where several children inherit cancer from a parent, the growth appears in each case in a different site. Nor are the precise histological characters of the growth at all faithfully preserved in the course of transmission; while it has been often observed that on the bodies of cancerous people innocent growths exist as well.[2] So that the inheritance does not appear to be a liability to a peculiar modification in a certain part, but a tendency to one or more of a group of modifications in one of many possible sites.

Once more we find ourselves driven to a choice between two alternatives, either of which excludes the transmission of acquired characters. For if new growths are really acquired characters, then it is not exactly what is acquired that is transmitted, but something broader than it. If, on the other hand, they are only acquired in a more general sense, they fall outside the limits of Weismann's sense of the term "acquired character."

(3) There remain for our consideration the third, and, in one sense, the most important, group of pathological data—those which answer to the qualifications of acquired characters in Weismann's stricter usage of the term. Here, if anywhere, would be the ground in pathology to select for proving the theory of the transmission of acquired characters; but it must be confessed that this is just the region in which that theory receives the least support. This group of pathological facts embraces a number of accidental lesions, such as scars and mutilations, which are certainly acquired in the strictest sense of the word. But the evidence for the theory seems strong only in the dubious cases, weak in the unexceptionable ones. We have examples of mutilations practised for many centuries by entire races, without being transmitted in a single instance. Nor is it the experience of surgeons that scars and mutilations which are the results of operations are ever transmitted. On the other hand, we have histories of tailless cats and hornless cows. But here everything turns upon the comparative certainty with which we can prove that the initial lesion was really in the first instance acquired. Have we here to do with an accidental lesion or a deformity? A closer investigation has, in many instances, rendered the latter the more probable explanation of the two. For example, in the case of the tailless cats, closer research made it appear that the irregularity involved an abnormality affecting many of the lower vertebræ. In other cases, the abnormality in the child was so little like that in the parent, as to suggest that it was a merely accidental coincidence of two different lesions in one site.[3]

If we turn to the results of experimental research, we are confronted by more than one remarkable series of experiments, upon the bearing of which it is impossible as yet to pronounce decisively. The most notable work done in this direction is, perhaps, a series of experiments upon guinea-pigs, undertaken by Brown-Séquard, and repeated by Westphal.[4] They produced epilepsy in a number of these animals by various methods—section of the cord, section of different nerves, &c.—and observed subsequently that certain of the offspring were epileptic too.

But there are several reasons which prevent our accepting these results as decisive. The records of the experiments are said not to be very perfect. Then it is not contended that epilepsy was uniformly transmitted. What happened was that each member of the offspring presented some morbid symptom—usually some nervous trait, such as epilepsy or paralysis. So that the result of Brown-Séquard's experiments would rather seem to be this. By producing one morbid trait in the parents, he set up a liability to one of several in the offspring. By producing a single character, he set up a tendency. All this is of extreme importance, and it may well be that the future has much that is interesting to reveal in this direction. But, meanwhile, it cannot be said to lend very much direct support to the theory now under discussion.[1]

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[1] See *Fortschritte der Medicin*, Bd. iii., 1885, p. 198; bacilli found in lungs of fœtal calf, æt. 8 months, whose mother was tuberculous.

[2] Ziegler and Nauwerck, "Path.," vol. i. pp. 393-94.

[3] Erichsen, "Surgery," seventh edition, p. 787.

[1] See "St. Bartholomew's Hospital Reports," 1866.

[2] Observation of Mr. J. Hutchinson, quoted in Fagge's "Medicine," vol. i. p. 106.

[3] For a number of other instances, see Weismann's essay on "The Supposed Transmission of Mutilations," *passim*.

[4] See Brown-Séquard, "Researches on Epilepsy," Boston, 1857; Papers in *Journal de Physiologie de l'Homme*, tom. i. and iii., 1858, 1860; *Archives de physiologie normale et pathologique*, tom. i.–iv., 1868–1872. Ziegler and Nauwerck, vol. i. p. 390. See also Weismann on Brown-Séquard, pp. 81, 310, 313; translation, edited by Poulton.

Again, the choice of lesion in these experiments was a somewhat unhappy one. Epilepsy is a symptom which can be produced in a number of ways—its proximate cause, if there be a single one, we are not as yet in a position to formulate. Attempts in this direction usually go no further than a vigorous and often highly poetical description, in which metaphors drawn from the phenomena of electricity are liberally employed. It might have been more advantageous to have aimed at the production of less equivocal symptoms, whose pathology is less disputed—such, for example, as facial palsy.

Lastly, we cannot exclude from these experiments the possibility of the introduction into the system of chemical poisons or even parasites, as incidental results of the operations.

But this does not by any means exhaust our stock of instances. The pages of pathology furnish us with more than one group of important facts which satisfy all the conditions of acquired characters.

Chief among these stand those numerous modifications of various organs which we regard, and rightly regard, from a clinical point of view, as part of a given disease, but which might perhaps be more correctly described as secondary adjustments made by the organism to meet certain primary morbid changes induced in different organs by the disease itself. Such, for example, is hypertrophy of the heart consequent upon valvular disease. Such hypertrophy is or is not a morbid symptom according to the point of view we happen to take. From the clinical standpoint it may be conveniently treated as part of the disease. From the biological standpoint it is an effort on the part of the organism to adjust itself to altered conditions brought about by the disease. It is certainly an acquired character, in the strict sense of the term.

An illustration will make this plain. Rheumatic fever is an hereditary disease.[2] Inflammation of the valves of the heart is common in rheumatic fever, and hypertrophy of that organ often follows as a consequent of this. But who would reckon hypertrophy of the heart as forming part of a rheumatic inheritance? It is true, no doubt, that whoso is heir to a disease is heir by implication to all the biological incidents of that disease. But he is not heir to them for the same reason. The one belongs to him as the inheritor of a morbid tendency, the other as the possessor of an organism. Diabetes, again, is in some cases markedly hereditary. Secondary characters are acquired in the course of this disease also; such as hypertrophy of the bladder or stomach. But, however doomed from his cradle to diabetes a peason may be, he is not born with an hypertrophied bladder and stomach. We should think it absurd that such accommodations as these should be made before they were wanted. If, then, we are right in regarding these as really acquired characters—and it is difficult to see how we can avoid so doing—it seems that pathology has here afforded us a sort of crucial experiment. Of the morbid characters of which sundry diseases are constituted, some are inherited, some are acquired—the one are constantly transmitted, the others, so far as we know, never are.

But no one pretends that every disease is inherited. Consider, for example, such a disease as lead-poisoning. Here, there is not, obviously, any element of heredity. That two people are not equally liable may be true enough; that predisposing causes exist is doubtless the case; but that does not prove an element of heredity. Predispositions may be themselves acquired, as is the case in alcoholism. In such diseases as lead-poisoning, we rightly stress the importance of the environment, and minimize inherited tendencies. But such diseases will be of little use to us here, unless two conditions are complied with. The first is that they leave durable and definite lesions behind them; the second is that such lesions are not inconsistent with the procreation of children. Of such lesions the familiar "wrist drop" of lead-poisoning may be cited as a good example. It is often durable; in not a few cases it is not cured; it is not inconsistent with the procreation of children. But there is no evidence to show that this or kindred lesions are ever transmitted. Facial palsy would be another instance, this malady being often of considerable duration. This group of cases constitutes another piece of negative evidence, not so important as the last, because these cases are rarer, but still not unimportant.

It can hardly be disputed that these characters are acquired in the sense under discussion. There must have been frequent opportunities of transmission, but we have no evidence of anything of the kind.

The general conclusion we have arrived at in this paper is that pathology, so far from offering any support to the hypothesis of the transmission of acquired characters, pronounces against it. We have seen that it is possible to bring up a mass of evidence, which seems at first sight to favour that hypothesis. On further consideration, however, it becomes clear that only a small portion of that evidence can be allowed to "rank."

A considerable number of facts must be rejected, because though there can be no doubt that the morbid characters here present are both acquired and transmitted, they are not acquired in the sense under discussion—that is, by the somatic cells exclusively—but by the entire organism.

A considerable number of facts, again, meet with a like rejection, because there is no question that here certain morbid characters are transmitted, yet even supposing them to have been acquired, it does not appear that precisely what was acquired is transmitted, but something broader and more general.

A considerable number of facts remain, which may be allowed to "rank" as genuine instances of acquired characters. These, if the hypothesis be correct, should be transmitted. But of such transmission we find little or no trace.

If we begin with scars and mutilations, even if the facts are not all on one side, the balance of evidence is decidedly against the hypothesis. If we appeal to the results of experimental research, the question is more open; but if the hypothesis does not encounter quite so decided an opposition in this quarter, it can scarcely be said to derive much support there.

If we pass into the main region of pathology, we have to use some circumspection in looking about for instances which shall be genuine examples of acquired characters. That such instances really exist it has been our endeavour to show, notably in those secondary characters which organisms acquire by way of accommodating themselves to the effects produced by disease. So far from being rare or recondite, these constitute a group of familiar and well-ascertained facts. If transmission has not occurred, it cannot be for want of opportunity—there must have been scores of such opportunities. That it has not occurred, constitutes a piece of very important evidence against the hypothesis under discussion.

Henry J. Tylden.

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[1] For other instances of supposed transmission of morbid characters artificially produced, see Ziegler and Nauwerck, "Pathology," vol. i. pp. 391–92; Brown-Séquard's operations on eyes, Mason's on the spleen.

[2] "Treatise on Medicine," by Fagge and Pye-Smith. Third edition, vol. ii. p 694.

A TRIP TO QUEENSLAND IN SEARCH OF CERATODUS.[1]

My main object in going to Queensland was to procure, if possible, the eggs of Ceratodus and the creature itself; secondly, I wanted to collect earthworms; and, thirdly, to see the country. In my main object I was quite unsuccessful, for the simple reason that this year Ceratodus did not lay its eggs till late on in November—two full months later than the time recorded by the only observer who had up till then procured them. University work forced me to return, not by any means empty-handed, but without the one thing which had tempted me to go north.

To save time, and avoid unpleasantness also, I went by train. It is a long weary ride across New South Wales, especially in warm weather. Unfortunately I left Sydney by the northern mail on Friday evening. There were very few carriages, and some of what there were were "engaged" for legislators who travelled home free and in ease whilst we who paid for our journey were huddled and crowded together. This discreditable state of affairs seems to be common at the close of each week during the sitting of Parliament in Sydney.

The journey north leads by the side of the Hawkesbury River, and after passing across the well-known bridge the train skirts the shores of what appears to be a succession of lakes. In reality, the winding river, shut in by wooded hills, expands every now and then into sheets of water, each of which in the gathering darkness seemed to be a little lake. About eleven o'clock you find yourself apparently running along through the streets of Newcastle, and stretching out eastwards see the long quays and open water leading out to the sea. The whole is brilliant with numberless electric lights, though you have an idea that in daylight coal dust would be a little too prominent. As it is, however, Newcastle is associated in one's mind with a series of flashing and twinkling lights prettily reflected in the water and with a very second-rate refreshment-room. Afer Newcastle you settle yourself down as comfortably as possible for a run northwards of 400 miles, through the night and greater part of the next day, to the Queensland border. You seem to get gradually more and more out of the world until at five o'clock next afternoon the train pulls up at the border station. By that time our number of passengers has been reduced to four. After looking about, a minute train, which at first sight you take for a toy, is descried at the end of the platform. Further searching shows a very narrow gauge line streaking away through the limestone hills northwards into Queensland. The original name of this border station was Wallangarra, but unfortunately this is now being changed to Jennings. It is a pity to lose the old native names and to substitute for them such ugly ones. One would have thought that a more effective plan of perpetuating the memory of legislators might have been devised.

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[1] Paper read by Prof. W. Baldwin Spencer, before the Field Naturalists' Club at Victoria, on March 14. Reprinted from the *Victorian Naturalist* for June and July.

Small though the railway is, it is very comfortable and well managed, and all officials uniformly courteous. The carriages are like the insides of omnibuses, with a broad seat all round the windows. On express trains the last car is always for smokers, and has a little balcony on which you can sit out in the open air right at the end of the train, and hence shielded from wind and dust. This is a most excellent arrangement. From Wallangarra the train runs to Warwick, and then, across the uplands forming the Darling Downs with their wonderfully rich dark-red soil, on to Toowoomba. Here the line turns nearly due east and begins to climb gradually to the top of the Dividing Range close to the eastern escarpment of which Toowoomba lies. Suddenly you turn a corner, the upland country ends abruptly, and the train zig-zags rapidly down the face of the lofty escarpment which rises directly from the flat coastal district. The sun was setting just as we reached the crest, and in the brief twilight we had magnificent glimpses of the distant plains with the abrupt hill sides and deep gorges in the foreground. Close upon midnight Brisbane is reached.

A slight difficulty arose in Brisbane with regard to my small amount of collecting material, but on learning that it was simply intended for scientific purposes, the Customs officials at once courteously saved me all trouble by allowing it to enter free of duty. In fact my experience in Queensland was that I met with the greatest courtesy from all officials, and the greatest kindness from such friends and strangers as it was my good fortune to be brought into contact with—an experience common, I believe, to all visitors to the Northern colony.

From Brisbane the line is now continued through Maryborough on to Bundaberg at the mouth of the Burnett River.

About seventy-five miles north of Brisbane the vegetation changes almost suddenly, and the line runs across a belt of country, perhaps twenty miles wide, of a semi-tropical description. To this we will return presently; suffice it to say at present that the traveller finds himself suddenly surrounded by palms and pines and fig trees, and sees all the tree trunks covered with epiphytic ferns—with great masses especially of staghorn and bird-nest ferns, and with orchids from which hang down long clusters of yellow blossom.

This belt of vegetation stops as suddenly as it began some few miles south of Gympie—a well-known gold-mining town, which lies by the side of the Mary River, and where I had been told that Ceratodus was to be had in abundance. Here I determined to stay, and began at once to make inquiries. To my disappointment I found that no one at the hotel knew anything about the animal, but I wandered forth in quest of information. The river itself was dirty with the washings from the mines, and looked anything but promising; however, I made for some miserable huts on the outskirts occupied by Chinese, and after a little trouble found a fisherman amongst them. This individual was decidedly apathetic, but after some time said that he might or might not be able to catch me a few. Wandering along by the river I began to feel rather as if I were searching for a needle in a haystack. However, I learnt that the fish certainly were to be caught, though some few miles away, but that there was no chance whatever of getting assistance from any blacks, simply because there were not any in the neighbourhood, and at that time I thought their assistance indispensable. It was late in the afternoon and I wandered on by the river searching for planarians and earthworms. Amongst the former I secured two specimens of a beautiful new species, to which Dr. Dendy has given the name of *Geoplana regina*, and also specimens of the almost cosmopolitan form, *Bipalium kewense*, and of *Geoplana cærulea*, a form common in New South Wales, rare in Victoria, and very abundant indeed in Queensland. This was, I believe, the first time on which land planarians had been collected in Queensland—not that there was any difficulty in finding them, but that no one had taken the trouble to look before. Amongst earthworms, I collected for the first time for myself a true perichæte—that is, one in which the little setæ, or bristles, form a complete circle round each segment of the body. In all our Victorian forms, without exception, there is a break in the mid-dorsal and ventral lines where the setæ are absent. True perichætes do not appear to come further south than the north of New South Wales. Under the logs also were specimens of a common Queensland worm, *Cryptodrilus purpureus*; of a new species of perichæte worm, *P. gympiana*; together with three species of frogs—*Pseudophryne bibronii*, *P. australis*, and *Limnodynastes tasmaniensis*.

During the evening I had the opportunity of talking to one or two who were well acquainted with the country, and was strongly advised to go on without delay to the Burnett River. I determined that this would be the wisest course to adopt, and accordingly packed up next morning, and after an hour or two's stroll round Gympie, during which I did a large amount of log-rolling with but scanty success, owing to the extreme dryness of the country, once more took train northwards towards Maryborough. I spent the night at a little wayside inn, where considerable surprise was evinced at my putting in an appearance; however, a wandering lascar turned up, so that I was more or less kept in countenance, and together we had tea in what was presumably a combination kitchen and scullery. During two or three hours' collecting I met with nothing but gum trees, endless ants and scorpions, a few stray specimens of *Geoplana cærulea*, and one or two lizards and frogs. I somehow had the idea that north of Brisbane everything would be at least semi-tropical, and could not at first help feeling disappointed to find myself, except in the small district mentioned before, surrounded by little else but gum trees, without a trace of a palm or of anything which looked at all tropical. Eastern Gippsland was really richer in vegetation and more varied in form of animal life than the part of Queensland in which I spent most of my time. In fact, so far as my experience yet goes, Gippsland, as a general collecting ground, would be very hard to beat.

Early in the morning I started in a mixed train along a branch line leading inland for some fifty miles, till it stopped apparently nowhere in special, and not far from a fine mountainous bluff. The station is called Biggenden, and here we found coaches waiting for us. A Queensland coachdriver is a most marvellous man, both in the way in which he accepts with almost pleasure any amount of luggage, and in the way in which he stows it all on board. From Biggenden came a hot ride of about forty miles across uninteresting country. The only township we passed was a small place known as "The Shamrock," not far from the goldfield of Paradise. After changing horses we started off again, seeing nothing but gum trees and a few emus and kangaroos. Among the gums were what are locally known as blood gums, whose light-coloured trunks are covered with reddish blotches, due to the exhalation of kino; woollybutts, which for perhaps ten feet above the ground have the trunk somewhat like that of a stringybark, and above this are quite smooth and whitish; and a form of gum called brigalow. This grows in clumps, and differs from all the others in having its foliage comparatively dense, so that it affords a good deal of shade. The cattle congregate in the shade, and these dark patches give a curious and characteristic appearance to the landscape. Every now and then we came across a few birds, known as squat pigeons. These have the habit of squatting on the ground when approached, and, being of a brownish colour, are hard to see. Sometimes they can be knocked over by the whip of an experienced driver.

Late in the afternoon we mounted a slight ridge and came down through a gap into the wide Burnett Valley. On either side of this rise low hills, and through the middle flows the river with a broad channel, occupied chiefly—except during the flood season—by long, broad stretches of sand. A short ride brought us to Gayndah, a long, straggling township on the river banks, and here I took up my quarters in the comfortable

Club Hotel. At one time Gayndah was the centre of a wool-producing district, and bears evident signs of having seen a better day.

Intent on meeting with Ceratodus, I made my way to Mr. Thomas Illidge, the postmaster of Gayndah, to whom I had been recommended, and I gladly take this opportunity of expressing my thanks to him, not only for the valuable help and information which he gave me, but for many acts of kindness which added greatly to the pleasure of my stay in Gayndah. I may here also express my thanks to my friends, Dr. Cole and Messrs. Frank and Virgil Connelly, from whom—though a complete stranger—I received most valuable help. If a naturalist wishes to meet with genuine kindness and every possible assistance, I can warmly recommend Gayndah to him.

One of the first things I learnt was that Dr. Siemen, of the University of Jena, had recently come to the Burnett district for the purpose of securing the eggs of Ceratodus, and the various development stages of Platypus and Echidna; and not only this, but that he had secured the services of the available blacks. I must confess to a feeling of something like chagrin at having come so far to meet with, apparently, no chance of success in what was my main object.

After sleeping over my preliminary disappointment, I determined on carrying out the only plan possible, which was to obtain one or two boys accustomed to the river, and, with their help, to at any rate get Ceratodus, and, if possible, the eggs. It was now well on in September—the time at which Mr. Caldwell had found that the animal had laid eggs—so there was still hope that I might secure them. Perhaps it may be well here to state briefly the special interest which attaches to this particular form Ceratodus. As you all know, there are two groups of animals—the fishes and the amphibia—of which the first live in water, and breathe by means of gills, whilst the second either spend, as the newts do, their whole life in water, breathing by means of gills, or else, like the frogs, spend the early part of their life in water, breathing by gills, and then come out of the water and breathe by lungs just as reptiles and mammals do.

Now there is a very small group of animals known as the Dipnoi, which are, we may say, intermediate between the fishes and the amphibia. They are neither so lowly developed as the fishes, nor so highly developed as the amphibia—in fact, they may almost be described as "missing links" which still exist, and show us the way in which air-breathing were evolved from water-breathing animals. If we simply went by their external appearance we should class them amongst fishes, which they closely resemble in many respects. Now, fishes have what is known as a swim-bladder, which is merely a long hollow process developed from the œsophagus. This serves, probably, mainly as a float, and not at all for respiratory purposes; but in the small group, Dipnoi, of which Ceratodus is one, this same swim-bladder becomes modified to act as a lung. Not only this, but, whereas in fishes the impure blood which is carried from the body to the heart passes to the gills, is purified there and then goes straight to the body, in the Dipnoi part of the blood goes from the heart to the lung, and then is carried back again to a chamber in the heart specially developed for its reception. In fact, in the Dipnoi we can see some of the earliest stages in the evolution of important organs of the body as we now find them in all animals above fishes.

At the present time only three examples of the Dipnoi are known to exist in the world—one form, Lepidosiren, lives only in the Amazon; another, Protopterus, is only found in tropical Africa; and the third, Ceratodus, occurs only in the Burnett and Mary Rivers, in Queensland. In past times, however, Ceratodus lived in other parts, such as Europe, as its fossil remains testify; and in Australia Prof. Tate has recorded the presence of its teeth in the strata of the Lake Eyre basin. In fact, Ceratodus is one of those rare forms of which fossil remains were found and named before the living form was discovered.

The habits of Protopterus have been studied, and it is stated that during seasons of drought it makes a cocoon of mud for itself, and breathes by means of its lung. On account of this habit, these forms have often been called mud and lung fishes.

My main aim, then, was to find the eggs of the Ceratodus. From Mr. Caldwell's published notes, which are only too brief, I knew that it deposited them much like some amphibians, such as the Axolotl, do, on weeds, and that he had found them in September.

To return now to Gayndah. I purchased a tent and provisions, and having hired two boys accustomed to the river, started away to camp out some few miles up the Burnett. The country was very dry and sandy, with all the creeks empty of water. The outcropping rocks are granitic, with basalt capping the hills around, and the disintegration of the granite appears to give rise to a vast amount of sand. Along the river itself there is an alternation of large sandbanks, where the stream is shallow, and of long deep pools with great granite masses. The banks are bordered by bottle-brush trees (Callistemon), which at that time were crimson with flowers, and alive with thickheads. Leaving my stores to find their way to an appointed spot, I kept by the river bank on the look-out for weeds, for without these it was hopeless to set to work. After a short halt at a station close to Mt. Debatable, where the sociable wasp (*Polistes ferrugineus*) was busy making its nest in the verandah, I walked on until we were some six or seven miles out of Gayndah but there was not a trace of weed in the river. Close in to Gayndah, there was a small quantity, but where we expected to find a good supply there was none at all, owing apparently to heavy floods which in the last wet season had swept down the river. Accordingly we turned back and pitched our camp not far from Gayndah. It was evening by the time we were settled down, and too dark to see the eggs, so we lit a fire and fished. It was a lovely moonlight night and the coolness was delightful after the heat of the day. The river is full of fish, and we caught sand eels and mud eels, jew-fish, perch, and bream, but not a single Ceratodus—or, as they call it locally, salmon. Turtles kept rising to the surface and showing their black heads above the water, and every now and then when we sat still we could recognize a Platypus. In the morning I set to work to search over the weed. One of my boys stripped and went into the river for it, whilst I sat half in and half out of the water looking carefully over each piece. In the hot blazing sun this was not enjoyable, and after some hours' work, and not the slightest sign of an egg, and when the small patch of weed was pretty well exhausted, I sat down to think, and questioned my boys closely as to where there was more weed. A little way on the other side of Gayndah they told me there was a backwater usually full of weed. Why they had not told me of this before I could not imagine, and the remarks made probably conveyed this idea to them. However, we were close to the end of this weed, and as we had to get to some more, I sent one boy into Gayndah to procure help in removing our camp, for which, fortunately, I had made previous arrangements In the afternoon I finally exhausted the weed and myself with no result, and for a change set to work to turn over a few logs. Amongst planarians, *Geoplana cœrulea* and *variegata*; amongst earthworms, *Cryptodrilus purpureus*; amongst frogs, *Limnodynastes tasmaniensis* and *Hyperolia marmorata*; and amongst lizards, species of Pygopus, Hinulia, and Egernia, and a small mammal, a species of Antechinus, rewarded my efforts, but everything was too dry, though the season was early, for anything very much in the nature of worms. Along the river banks endless numbers of the beautiful butterfly *Danais erippus* attracted my attention. It was feeding on the plant (Lanthana) along with which it has been introduced. In the river itself was to be seen the curious water lizard *Physignathus lesueurii*, of which we caught a small specimen, and also the frog *Hyla lesueurii*, whilst the Callistemon trees contained plenty of a little green species of Hyla which the boys used as bait for fishing, and which appears to be new to science. I also caught this same frog on window panes at night in Gayndah, where, like a moth, it goes to the light. As the evening came on the mullet began to jump. They feed especially on a filamentous alga which grows in the water, and contains numerous crustaceans, especially a prawn-like form, for the sake of which they eat the alga. The latter is used as bait for them. At night we caught a large mud eel, five feet long, which we eagerly drew into land, thinking it to be a salmon. I tried sugaring the trees, but it was of no use, not even a single ant put in its appearance, and thus ended another day of hard work and disappointment.

In the morning I had my boys up by 4 a.m., and before six we were out of camp, and by nine o'clock had our tent pitched by the side of a backwater on the other side of Gayndah. This contained plenty of weed, and here I spent some days. We procured a long pole, with three prongs at the end, to pull the weed up with. We used to get a large bucketful at a time, and then go over it piece by piece. This process had to be conducted under a hot sun, and the result was that my arms became swollen to about double their natural size—so much, indeed, that I could not sleep with anything like comfort, since the slightest pressure woke me up. The final result was that I did not see the slightest trace of any Ceratodus eggs, though, had they been there, there is no doubt but that we should have found them. I then sent one of my boys down the river for some miles to see if there were any more weeds, but there were none to be seen. Just at this juncture I heard of some blacks, but on trying to secure them found that they were anticipating a "muster" on one of the neighbouring stations, and were not to be procured. Seeing no prospect of getting what I wanted, and being none the better for my exposure to the sun, I went into Gayndah.

Here I may, perhaps, say something as to some conclusions I had come to with regard to the habits of Ceratodus. With the exception of the brief account given by Mr. Caldwell as to the laying of its eggs on weed, and the curious amphibian-like embryos, we know little about the natural history of the animal. As before said, it is confined to two Queensland rivers—the Mary and the Burnett, and my experience is limited to the latter. Firstly, with regard to the animal's name. The Dipnoi have two popular names—"lung fishes" and "mud fishes"—the latter given to them because, in the case of Protopterus, the animal may live for a part of the year in mud. The Ceratodus is not known locally by either of these names; it is, however, sometimes called the "barramundi" and sometimes the "salmon." The first of these is, however, really that of a true osseous fish (*Osteoglossum leichardtii*), which lives chiefly in the Dawson and Fitzroy Rivers, further north than the Burnett. The second is a fanciful name, given on account of the very pink-coloured flesh of the animal. Beyond this there is no resemblance whatever between the real and the so-called Burnett "salmon." Mr. Saville Kent, in his report on fishes to the Queensland Government, states that Ceratodus is a valuable food fish. This is a curious mistake. Its flesh is very oily, coarse, and disagreeable, and it is but rarely eaten, and then only by Chinese and those who can afford nothing better. There is thus, I am thankful to feel, not much fear that so interesting an animal will become rapidly exterminated.

Now, as to its method of life. Ceratodus is a big fish, and may reach the length of six feet, and even more. I believe the largest ever caught weighed eighty-seven pounds. It is always to be met with in the deep pools, and not in the shallow waters, and it is important to notice that these pools are many of them of considerable extent, some more than a mile long. In the hottest summer they contain a good supply of water, and thus, though occasionally a Ceratodus may, of course, find its way into a shallow pool which gets dried up, normally no such thing happens, and the animal passes its whole life in water. The usual idea is that the lung is of service to the animal, as in the case of Protopterus, when the waters practically dry up. I very much doubt if Ceratodus ever makes for itself a mud cocoon, as Protopterus does. It may possibly, but very rarely, bury itself in mud, but the fishermen with whom I spoke, and who were perfectly well acquainted with the animal, knew nothing of its ever doing this. On the contrary, I fancy that the lung is of at least as great service to the beast during the wet weather as during the dry season—and probably even of greater.

Normally, then, we may say that Ceratodus never leaves the water. If by any chance it gets out of the water it is perfectly helpless. You may put one close to the edge and there it lies passively. Its weak limbs are quite incapable of sustaining the weight of the body. Nor can it live out of the water, unless kept constantly damp, for more than a very few hours—not, indeed, so long as the jew-fish from the same river. In the water, however, it constantly uses its lung. Sitting by the stream when all is quiet in the evening, you can hear a diminutive kind of spouting going on, the animal at intervals rising to the surface and expiring and inspiring air much as a minute whale might do. Out of the water, too, it does not open and shut its gill flaps like an ordinary fish, but they remain tightly shut, and the animal opens and closes its mouth, to all appearances breathing like one of the higher forms.

If we consider the environment of the Ceratodus we shall see that there are two special and constantly recurring conditions under which a lung would be useful to it.

In the wet season the tributary creeks, dry in summer, become transformed into roaring torrents, and when once you have seen the great sandbanks along the river bed and the dry sandy country through which the creeks pass, you can easily recognize what a vast quantity of sand must be brought down during the course often of a very few days, and how thick the water must become with fine particles. On the other hand, during the hot season there suddenly grow with enormous rapidity great quantities of water weeds. The river is then at its lowest and the decaying vegetable matter will often render the water foul. Under either of these conditions you can see that the possession of an organ enabling the animal to remain in its natural element and yet breathe air directly will be of great advantage to it. It is the shallower pools especially which become chocked with weeds, and since normally the Ceratodus lives in the deeper pools, in which is the purer water, it is, I think, very probable that the flood season, when the water is disagreeably full of sand and mud, is the time when the lung is of greatest service.

In Gayndah I learned that Dr. Siemen was camped out some forty miles up country, where the Auburn and Bowen Rivers join the Burnett, close to one another. Accordingly I made up my mind to go up the river, both to see him and to search for weed. The difficulty was how to get there. However, I met with a friend in the person of Mr. Bailey, proprietor of the Queensland Hotel, who, at considerable inconvenience to himself, promised to see me through the difficulty; and, taking one of my boys with me, we left Gayndah early one morning, before 4 a.m.

The country was extremely dry and sandy, with poor gum trees, and every now and then a patch of brigalow. By 10.30 we reached a wayside accommodation house, and then in the heat of the day we started off along a most miserable track across country as utterly uninteresting and monotonous as can well be imagined. We had two good dogs with us, and the only break in the monotony was when they put up a big "iguana." Most were much too quick for them, but one they got hold of, and it was wonderful to see how they stuck to him without getting within reach of his mouth. When all was over I slung him over a dead trunk, to get his head on the way back. However, when we came back he was not perfectly fresh, and was left behind. By 4 o'clock we had crossed the Bowen River and pitched our camp about a mile beyond. Then I walked on to Dr. Siemen's camp. My advent was announced by the yelping of sundry mongrels, the property of a small camp of blacks. On these animals I kept a sharp look-out. Dr. Siemen I found living in comparative luxury, and from him I received a most cordial welcome. We spent the evening most pleasantly talking over matters of common scientific interest. Three of his blacks came in with a few Echidnas. I learnt from him that he had been no more successful than myself in procuring Ceratodus eggs—that, in fact, they had not begun to spawn yet. Unlike myself, however, he was able to stay there until they did spawn, and most generously offered to procure certain material for me. There was a small amount of weed in the river but not a trace of an egg. On cutting open the body of a "salmon" I found the spawn inside, looking very similar, indeed, to that of a frog, each separate egg being black in colour at one pole. It was evidently not yet quite ripe for laying. The season when Mr. Caldwell got his eggs in September seems to have been an exceptional one as regards the temperature and amount of weed in the river. There had been no big flood for some time previously to his visit, so that the river was full of weed and everything was favourable for the depositing of spawn. This season, as luck would have it, the warm weather started rather late and the weeds had been largely washed away by heavy floods, the river at the end of September being comparatively high. I think it safe to say that, granted the presence of eggs, they could be got by "whites" just as well as by "blacks." Any collector going at the right time and not frightened of tiring and tedious work could get them for himself now that the manner of spawning has once been ascertained. Each egg, surrounded by a little gelatinous capsule, is laid on weed, but I think, from what I heard with regard to Mr. Caldwell's methods, that he found it necessary to spend a very considerable time in the neighbourhood of the river whilst the embryos were slowly developing, as they were not easily and safely carried about. The next day Dr. Siemen and I spent together with, I trust, mutual enjoyment—at all events, to myself it was one of the pleasantest days I spent in Queensland. I did a small amount of collecting, but it was far too dry and sandy to get anything in the way of worms. Down by the river I came across a black woman and pickaninny fishing, but they were frightened when I spoke to them, and fled. There were large numbers of *Danais erippus*, and of a beautiful species of Acræa with transparent wings. Late in the afternoon I attempted, but with not very great success, to photograph some blacks. One especially, named Frank, had his back scored with cicatrices in regular pattern. I spent the evening till 11 o'clock with Dr. Siemen, and said good-bye to him, wishing sincerely that he might be successful in his endeavours to secure what we were both in search of, and what it was perfectly evident that I myself could not obtain.

I may here say that Dr. Siemen had with him the best of the blacks who were with Mr. Caldwell, and who secured for the latter the eggs of Ceratodus. These blacks were fine and powerfully-built fellows; but here, as everywhere else, rum and disease are rapidly lessening their numbers.

On the way back our dogs started many big lizards, and it was amusing to see one of them hanging on to the tail of a large *Cyclodus gigas*, whose head and body were hidden in the hollow of a log. Jew lizards we met, as well as species of Hinulia and Liolepisma. We camped by the Burnett, some twenty miles out of Gayndah, and spent the evening fishing in a little backwater. There are two kinds of turtle in the river, the long-necked (*Chelodina longicollis*) and the short-necked (*Chelymis macquariensis*), and sometimes one is surprised at pulling out a turtle instead of a fish. Next day we made our way back into Gayndah, passing by large patches of grass trees in full flower, with swarms of the little black native bees hovering around them. Just as we were passing through a mob of travelling cattle our dogs started two kangaroo rats (*Bettongia*, sp.). There was a general scattering as the little animals, with the dogs in full chase, ran through the mob. After a short run one was caught, which had in its pouch a single small young one not more than 1½ inch long.

I stayed a few days in Gayndah, hoping to make a collection of earthworms, which up till then there had been very little chance of collecting. The name of the township will be well known to Australian etymologists, since it was here that Mr. Masters made a very fine collection; he was fortunate enough to have almost a year in the district, and thus secured forms at all seasons. About a mile behind the township is a large stretch of scrub, where I spent a considerable time, often accompanied by one or other of my friends—Messrs. Illidge, Cole, and Connelly—to whom I am indebted for help in the laborious task of digging out worms from dry ground. My favourite place was a large patch centering in a big bottle tree, *Sterculia quadrifida* (?). Here was an open space, lightly timbered with small trees of *Melia azedarach*, the light green foliage of which formed a strong contrast to the sombre foliage of the dense scrub all around. Besides eucalyptus and bottle trees, the scrub was made up of such trees and shrubs as *Geijera muelleri* and *salicifolia*, which were covered with small yellowish flowers, *Leptospermum lanigerum*, *Bursaria spinosa*, *Nephelium* (sp.), *Hovea longipes*, *Solanum stelligerum*, &c. I am indebted to the Baron von Mueller for his kindness in giving me the names of plants, to Mr. C. French for names of Coleoptera, to Mr. A. H. S. Lucas for names of amphibia and lizards. From the open spaces alleys lead away into the recesses of the scrub, and along these numbers of the beautiful *Danais erippus*, *Papilio erectheus*, and *Acrasea* (sp.) kept flying to and fro. Of birds, probably because I was not specially on the look-out for them, I saw very few.

The two most numerous forms of life were ants and millipedes. The moment you put anything which could serve as food for them on the ground, the former appeared as if by magic. Several times they spoilt butterflies just while I put them down on the ground and made a paper bag for them. They always bit off first the little knob at the end of the antenna. White ants of course abounded, and in the tree trunks were swarms of native bees. There were not as many logs to turn over as could have been wished for, and the ground also was rather too dry and sandy.

We began by digging around the base of the big bottle tree, and, after digging some time, came across some large worms, about two feet in length. These differ in habit from any others I have collected. The burrow runs down for perhaps two feet, and then opens into a small chamber. The head end of the worm lies usually a short distance up the burrow, whilst the greater part of its length is twisted into a knotted coil, and lies in the chamber which may also contain one or two smaller, immature forms, evidently the young of the larger ones. Under and in rotten logs you often meet with a shortish, stout worm, perhaps six or eight inches in length, which, at first sight, differs very much from the long one. Its body is stiff, and the surface comparatively dry, whilst the other is four or five times its length, the body soft and the surface always very slimy. The short one I met with all along the Burnett River, at Gympie and in the palm district between this and Brisbane, whilst Mr. D. Le Souëf collected it at Toowoomba. It is the *Cryptodrilus purpureus* of Michaelsen, and, much though the two differ in habits and appearance, the long one is at most a variety of the short, typical form. I only got it in this one spot. In the scrub were some four new species of the same genus, and three new species of a genus (Didymogaster) of which previously only one species had been described from New South Wales, by Mr. Fletcher. Of the typical Victorian genus, Megascolides, to which our large Gippsland earthworm belongs, I did not find any example in Gayndah, but the Perichætes were fairly well represented.

Most of the earthworms were secured under fallen logs and in rotten trunks of the bottle tree. In times of drought the latter are cut down, and, containing a great amount of moisture, are eaten readily by cattle.

The season was too early for beetles, but amongst others I secured specimens in the family Carabidæ of *Carenum deauratum* and *bonelli*, *Eutoma* (sp.), *Philoscaphus mastersii*, and *Homalosoma hercules*; and, in the Paussidæ, of *Arthropterus* (sp.). One species of the genus *Leptops*, in the Curculionidæ, simply swarmed on the bark of the bottle trees and some of the upturned logs in the more open parts were alive with the little red form, *Lemodes coccinea*.

A short time before leaving for Queensland I had been struck with the presence of curious laterally-placed segmental openings in a very large millipede from Fiji, which Mr. French had kindly forwarded to me. In the Gayndah scrub—where smaller, but still large, millipedes abounded—I was interested to find the meaning of these openings. Each one is connected with a gland, and, when irritated, the animal passes out a few drops of a most obnoxious fluid, of a red-brown colour, the function of which must be protective. Whilst on this subject, I may mention that one morning, when Mr. Frank Connelly and myself were digging for worms, we accidentally cut in two a cockroach. From between the segments in its back it poured forth a milky white fluid, possessing an odour so execrable and pungent that it drove us from the spot.

Under logs we found, also, of land planarians, *Geoplana cærulea* and *variegata*, and amongst Vertebrata, the frogs *Limnodynastes tasmaniensis*, which was common everywhere, and *Hyperolia marmorata*. Of lizards, we secured species of Phyllodactylus, Pygopus, Grammatophora, Hinulia, Liolepisma, and Egernia. Snakes were rare, only the genera Morelia, Furina, and Hoplocephalus being represented. Whilst in the scrub I did not see a single marsupial.

On the road from Biggenden to Gayndah I had been struck with the appearance of two small hillocks capped with basalt. The country all round was thinly wooded with nothing but gum trees, but just the tops of these two hillocks were rich with vegetation, though each was at most fifty yards in width. Dr. Cole, Mr. Illidge, and myself drove out to see if there were anything worth collecting. Unfortunately, since I had passed along the country had been fired and everything was as dry and parched as it well could be. However, just the very cap of the hills still formed a strong contrast to the surrounding country, and here we found growing—though nowhere else, apparently, except in these two very limited areas—*Damara robusta*, the Queensland Kauri, *Cupania xylocarpa*, *Micromelum pubescens*, *Carissa brownii*, *Citriobatus* (sp.), and amongst ferns a rich growth of *Polypodium* (sp.), and *Adriantum* (sp.). Animal life was almost absent. We disturbed three wallabies, but except these and a few millipedes and scorpions and endless ants, there was nothing to be seen.

My time was passing by rapidly, and though I would much have liked a few more days in the Gayndah scrub, it was a choice between this and two or three days in the palm district between Gympie and Brisbane. Regretfully I left Gayndah, and taking the coach back to Biggenden, found myself in the evening in Maryborough. In the morning I had about two hours to wander about. Close to the town were camped some blacks. It was curious to note how they had adapted themselves to their environment. They had made their "humpies" out of old sheets of corrugated iron. A semi-clothed native lying down in the shelter of a mia-mia made of English corrugated iron formed as incongruous a mixture as could well be imagined. Early in the afternoon I left the train at Cooran and took up my quarters in a delightful little wayside inn surrounded by ferns. On going up to the house I detected at once the genuine Lancashire dialect, and knew that the owner hailed from within ten miles of Manchester. I was accordingly made welcome, and wandered out to do a little collecting before evening came on. I found myself just on the northern border of the palm scrub which ran in a broad belt of about twenty miles width across the country from east to west, inland from the sea coast. The country was fairly hilly with a few isolated peaks standing out clearly. I was just at the base of one of these—Cooran—and to the south lay two more—Cooroora and Pimparan. South from these again the ridges increased in height, and then the country fell away into the slightly undulating plains which stretched eastwards towards Bribie Island and southwards to Brisbane. Some remarkable peaks, called the Glass Mountains, mark the southern end of the hilly district.

So far as animals are concerned, I was much disappointed with this palm scrub, but equally delighted with the richness of the vegetation.

Commencing first near to Cooran, I followed back the line and "log-rolled," finding a few worms and four land planarians (*Rhynchodemus obscurus*), a small, dark-coloured form, and *Geoplana cærulea* and *variegata*, together with specimens of a very small new white species, to which Dr. Dendy has given the name of *G. minor*. After long searching I came across *Peripatus leuckartii*, very dark purple in colour and evidently similar to the typical form and without the curious diamond-shaped markings characteristic of the Victorian form. Though searching hard, I only found nine specimens altogether, and all these close to Cooran. Most of my time was spent in this scrub at different parts, and usually in company with George Martin, the son of my Lancashire friends, who helped me very considerably in collecting. The scrub was very thick with vines and prickly lawyers and barristers and supplejack, making progress tedious, and there were comparatively few logs on the ground. What delighted me most were the ferns. The trunks of the pines and gums were often covered over with them and with orchids. High up were enormous clumps of the bird-nest fern (*Asplenium nidus*), and larger ones of the staghorn (*Acrostichum alcicorne*). Some of the latter measured fully twelve feet through, and from them hung down lovely pendant fronds of smaller ferns, especially of *Polypodium tenellum*, which is locally known as the feather fern. On the ground grew various species of Davallia, Adiantum, Pteris, Doodia, Aspidium, Polypodium, &c. Perhaps the most beautiful of all were the large and delicate fronds of *Adiantum formosum*. There were apparently three forms of palms—species of Ptychosperma, Livistona, and Kentia. The latter is very common, and usually known as the walking-stick palm. In the scrub were great pine trees, and under the bark stripped off from these, and lying about in large slabs, I expected to find any number of worms and insects, but was much disappointed. Millipedes and scorpions were there, and two large forms of land shells; but scarcely an insect to be seen, and not a planarian or peripatus. I got a few new species of earthworms, of which, again, the commonest form was *Cryptodrilus purpureus*; and in rotten logs, which, unfortunately, were few in number, were large forms of cockroaches. The earthworms formed the best part of my collection here, and comprised representatives of five genera—Perichæta, Megascolides (one species, the only one found), Cryptodrilus, Perissogaster, and Acanthodrilus. The latter is only recorded, as yet, from Northern Australia, where there are two species, and is characteristic of New Zealand. Perissogaster is peculiarly Australian and has only three species yet known. My specimens were obtained by digging on the banks of a creek at Cooran and were whitish in colour and about 1 to 1½ feet in length. The boys use them for fishing, quite unaware of their scientific value.

In Queensland, as in Victoria, I could very rarely, indeed, find traces of casts made by worms or of leaves dragged down into the burrows, and it would appear that here, as in Africa, the ants are of more use than the worms as agents in turning over the soil. Under the bark and logs were a few frogs—*Pseudophyrne bibronii* and *coriacea*, *Crinia signifera*, and a female specimen of *Cryptotis brevis*. In certain spots there were great numbers of trap-door spiders. Some of the tubes, which led for about 2-4 inches down into the ground, were an inch in diameter. The top of the tube, with its semi-circular trap-door, projects slightly above the surface.

One of the most striking features of the scrub were the epiphytic orchids, of which, owing to its size and large pendant masses of yellow-brown flowers, *Cymbidium canaliculatum* was the most noticeable. In parts the ground was crimson with the fallen berries of a species of Eugenia: we cut one down about sixty feet high, laden with fruit, which has a tart taste, and from its colour and size has caused the tree to be known as the native cherry. Another Eugenia has a large purple fruit, and is hence known as the native plum. High up, some fifty feet above ground, we saw hanging down clusters of light brown fruit. Luckily there was a hanging vine close at hand, and up this George Martin went like a monkey. The fruit belonged to the tree *Dysoxylon rufum*, and each was covered over with innumerable minute stiff hairs, which pierced the skin in hundreds. Other plants we noticed were the wistaria, which here grows wild, *Dracæna angustifolia*, and one which Baron von Mueller has marked as rare—*Rhipogonum elseyanum*. Two dangerous ones are common, one with large bright green leaves and succulent sheathing stalks, which is locally known as the "Congey Boy"—this is eaten greedily by the native turkeys, but has the effect of making a man's tongue swell to an enormous extent; the other is the stinging tree, *Urtica gigas*—the sting of this is extremely painful, and seems to prove fatal to horses, driving them rapidly frantic.

Close by the base of Mount Cooroora, a beautiful specimen of *Macrozamia denisoni* in fruit was growing, and on Mount Cooran the rock on the western side was completely overgrown with staghorn and bird-nest ferns and with an orchid, *Dendrobium* (sp.), with beautiful clusters of delicate white flowers, amongst which trailed *Kennedya rubicunda*, its bright red blossoms contrasting strongly with the pure white of the orchids.

My last day I spent at the Glass Mountains—curious cone-like basaltic structures rising abruptly from almost flat country. The day was oppressively hot, making it no small exertion to even turn over a log, and as the sun went down a heavy storm came up, and from the train I caught my last glimpses of this delightful district lit up by almost incessant flashes of brilliant lightning.

SCIENTIFIC SERIALS.

The American Journal of Science, July.—The change of heat conductivity on passing isothermally from solid to liquid, by C. Barus. The method employed was a modification of Weber's, who placed a thin, wide, plane-parallel plate or layer of the substance to be examined between and in close contact with two thick plates of copper. The system was first heated so as to be at a given temperature throughout. It was then suddenly and permanently cooled at the lower surface, and the time-rate at which heat travelled from the top plate to the bottom plate, through the intervening layer, was measured by a thermo-couple. From these data the absolute thermal conductivity of the layer may be computed, the constants of the system being known. In the experiments discussed, the liquid was thymol, which can be kept either solid or liquid between 0° and 50° C. This was heated above its melting point, and introduced through a central hole in the upper plate; it was then allowed to cool down until undercooled. The temperature was regulated by enclosing the whole apparatus in a sheet-iron jacket, through which water was kept circulating. The lower plate could be cooled by flushing it with water from below. The difference of temperature of the plates was measured by means of a copper german-silver couple. The liquid was solidified by introducing a crystal through the central hole. The results obtained gave for the absolute conductivity of thymol in g/cs:

Solid thymol at 12°, $k = 359 \times 10^{-6}$
Liquid thymol at 13°, $k = 313 \times 10^{-6}$

The thermometric conductivity was found to be—

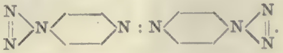
For solid thymol at 12°, $= 1077 \times 10^{-6}$
For liquid thymol at 13°, $= 691 \times 10^{-6}$

—On polybasite and tennantite from the Mollie Gibson mine in Aspen, Colorado: by S. L. Penfield and Stanley H. Pearce. Large quantities of polybasite or "brittle silver" have been mined nearly free from gangue, assaying from 10,000 to 16,000 ounces of silver to the ton. Tennantite, arsenical tetrahedrite, or "grey copper," was found in smaller quantities, containing about fourteen ounces of silver. The rich ore occurs between a hanging wall of black carbonaceous shale and a foot wall of grey magnesian limestone, which is probably of lower carboniferous age. The ore is richest and most abundant immediately under the black shales. Other minerals observed are native silver, argentite, galena, sphalerite, siderite, barite, and calcite.—Post-Laramie deposits of Colorado, by Whitman Cross. This paper, published by permission of the director of the United States Geological Survey, deals with some beds occurring between the lowest eocene and the marine cretaceous deposits, which have hitherto been classed with the Laramie formation of the Rocky Mountains. The age of the firm grey sandstones and coal-measures of the latter has long been doubtful, and they have been variously described as secondary and tertiary. In the Denver region, two beds are found overlying the Laramie unconformably, the one consisting of a pebbly conglomerate, the other of débris of andesitic lavas; they have been termed the Denver and Arapahoe formations respectively. Their equivalents have been found in various other parts of Colorado. When, after the continental elevation which caused the retreat of the Laramie seas, sedimentation began again, it was in comparatively small seas or lakes. Succeeding the first period of lake-beds came a time of great volcanic outbursts over a large area. The length of geologic time occupied may not have been very great, but the extent of country in which eruptions occurred at this time, and the great variety of lavas found in the Denver and Middle Park regions, argue for the decided importance of the event as a dynamic manifestation. The writer wishes to advocate the restriction of the term Laramie, in accordance with its original definition, to the series of conformable beds succeeding the marine Montana cretaceous, and the grouping of the post-Laramie lake beds in another series, to which a comprehensive name shall eventually be given.—On the alkali-metal pentahalides, by H. L. Wells and H. L. Wheeler. With their crystallography, by S. L. Penfield. An account of the preparation and properties of compounds of the formulæ CsI_5, $CsBr_5$, $CsCl.Cl_3I$, $RbCl.Cl_3I$, $KCl.Cl_3I$, $NaCl.Cl_3I.2H_2O$, $LiCl.Cl_3I.4H_2O$. The first is triclinic, the third, fourth, and fifth are monoclinic, and the Na salt is orthorhombic.—Fossils in the "archæan" rocks of Central Piedmont, Virginia, by N. H. Darton. Remains of crinoids belonging to the upper Ordovician fauna were found in the roofing slate of Arvon, Buckingham County, Virginia, which has hitherto been classified as Huronian.—Notes on the Cambrian rocks of Virginia and the southern Appalachians, by Chas. D. Walcott. It is shown that towards the close of middle Cambrian time, and during upper Cambrian time, there was a decided continental movement, resulting in the depression of the interior continental plateau, and that this was accompanied by the formation of conglomerates of the older Cambrian rocks in the valley of the St. Lawrence, and by a great deposition of sediments of later Cambrian time in the southern Appalachian region.—Synthesis of the minerals crocoite and phœnicochroite, by C. Ludeking, Ph.D. This was accomplished by exposing for several months to the air a solution of lead chromate in caustic potash in a flat dish. A mixture of the two kinds of crystals resulted, which could be easily sorted by means of a pincette.—A hint with respect to the origin of terraces in glaciated regions, by Ralph S. Tarr. Tracing a resemblance between the flood terraces of the Colorado in Texas, and the glacial terraces of the Connecticut.—Occurrence of a quartz boulder in the Sharon coal of north-eastern Ohio, by E. Orton.—A method of increasing the range of the capillary electrometer, by John Whitmore. An account of some experiments performed in the Sloane Physical Laboratory of Yale College, with a view towards improving the mercury and sulphuric acid electrometer as constructed by Lippmann and Pratt. Instead of having alternate bubbles of the two liquids, the surface of the mercury exposed to oxygen polarization was increased by blowing the tube into bulbs at the junction. A series of bulbs was blown, spaced at equal intervals along a capillary tube, the diameter of the bulbs being two centimetres, that of the tube 0·6 mm.; then the tube was so bent, that the whole contained as many U-shaped parts as there were cells. One arm of each U was provided with a bulb, which was situated at a distance of two-thirds the height of the U from the base. The apparatus was filled by connecting it with an aspirator, and drawing in sufficient mercury to half fill each bulb, after which dilute sulphuric acid was added by the same means. Platinum electrodes were used, and the variations in the height of the mercury columns produced by the E.M.F. examined, were read by means of a cathetometer. The deflection produced by a standard Clark cell was 3·20 mm. The range of the instrument is limited by the E.M.F. required to produce continuous electrolysis, but it was found that it could be considerably increased by using a larger number of cells in series. It is possible to determine with this electrometer the E.M.F. of a cell correctly to 0·001 of a volt.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, June 16.—Prof. A. Crum Brown, F.R.S., President, in the chair.—The following papers were read:—Contributions to an international system of nomenclature. The nomenclature of cycloids, by H. E. Armstrong. An account was given of the proceedings at the recent Conference on Chemical Nomenclature at Geneva, and attention was directed to the significance of the chief resolutions. A report of the conclusions arrived at by the Conference has already appeared in NATURE (this vol., p. 56).—The production of pyridine derivatives from the lactone of triacetic acid, by N. Collie and W. S. Myers. The product of the interaction of ammonia and triacetic lactone is most probably an αγ-dihydroxy-α-picoline. By the action of phosphorus oxychloride on this substance a compound possessing all the properties of a dichloropicoline is obtained, and on passing this, together with hydrogen, over heated zinc-dust, α-picoline boiling at 128–129° is produced. The melting points of the platini- and auri-chlorides, obtained from the synthetical alkaloid, agree with those given by the corresponding compounds prepared from pure α-picoline which was made by heating pyridine methiodide.—The fermentation of arabinose by *Bacillus ethaceticus*, by P. F. Frankland and J. MacGregor. The products are qualitatively the same as were obtained in the fermentations of glycerol by the same organism, consisting of ethyl alcohol, acetic acid, carbon dioxide, hydrogen, and traces of succinic acid, together with another acid which was not identified. When the fermentation is conducted in a closed space a notable proportion of formic acid also occurs among the products. In this case the products are formed approximately in the proportions—$3C_2H_6O$, $3C_2H_4O_2$, $4CH_2O_2$, the formic acid as well as the carbon dioxide and hydrogen found being all collected together as formic acid in this statement. In the fermentations conducted in flasks plugged only with cotton wool, on the other hand, the alcohol and acetic acid were formed in the proportion $2C_2H_6O$, $3C_2H_4O_2$. It appears, therefore, that in the fermentation of arabinose by *Bacillus ethaceticus*, the proportion of acetic acid to alcohol is greater than in that of dextrose, and still greater than in the cases of mannitol and glycerol, but less than in that of glyceric acid.—Resolution of lactic acid into its optically active components, by T. Purdie and J. W. Walker. The authors have resolves ordinary inactive lactic acid into lævo- and dextro-lactic acid by taking advantage of the different solubilities of the strychnine salts of these components. Strychnine lævolactate is considerably less soluble in water than the dextrolactate, although both salts may be crystallised. By fractional crystallization of the mixed salts and subsequent removal of the strychnine from the crystals and mother liquor, by means of ammonia or barium hydrate, solutions were obtained which were respectively dextro- and lævo-gyrate. The dextrolactate yielded a zinc dextrolactate having the same composition and solubility as zinc sarcolactate. A well-defined dextro zinc ammonium salt of the composition $Zn.NH_4\,(C_3H_5O_3)_3,\ 2H_2O$ having the specific rotatory power $[\alpha]_D = +6{\cdot}49$ (approx.) was prepared. The dextrogyrate salts yield a lævogyrate acid, which, like sarcolactic acid, gives an oppositely active anhydride. The quantities of oppositely active acids separated from each other by means of the strychnine salts possessed equal amounts of optical activity. Fermentation lactic acid is thus shown by analysis to consist of two oppositely active isomeric acids, one of which is identical with dextrogyrate sarcolactic acid, and the other with the lævogyrate acid prepared by Schardinger by the bacterial decomposition of cane sugar.—A new method for determining the number of NH_2 groups in certain organic bases, by R. Meldola and E. M. Hawkins. In order to ascertain the number of NH_2 groups present in certain organic bases the authors propose to form the azoimides; on analysis of these substances, the number of amidogen groups which have been diazotized, can be determined. For example, paradiamidoazobenzene $(NH_2.\,C_6H_4)_2N_2$ was diazotized and converted into tetrazoperbromide in the usual way. This latter substance, by the action of ammonia, yields lustrous silvery scales of the azoimide.



The analysis of this substance proves without doubt that two amidogen groups were present in the original base.—The existence of two acetaldoximes. Second notice, by W. R. Dunstan and T. S. Dymond. The authors have more fully investigated the change undergone by acetaldoxime on heating (see NATURE, this vol., p. 94). The pure crystals melt at 46·5°; after heating at 100° for a few minutes the liquid does not begin to crystallize until 13°. On separating the crystals now formed, and cooling the liquid still more a further crop of crystals is obtained. Each of these separations is found to melt at 46·5°. Acetaldoxime therefore exists in two modifications, one, the crystalline form melting at 46·5°, and the other, a liquid form which the authors find cannot be obtained in a pure state, as when it approaches purity it partially reverts to the modification melting at 46·5°.—The dissociation constants of organic acids, by J. Walker. The author has measured the dissociation constants of a number of organic acids and ethereal salts.—Note on the preparation of alkyl iodides, by J. Walker. The author has devised a method for conveniently and rapidly preparing considerable quantities of methyl and ethyl iodides. The apparatus employed consists of a modified fat extraction apparatus, by means of which the iodine is dissolved by the condensed alcohol, and runs into a vessel containing the phosphorus and alcohol. The method gives a good yield, and may be applied to the preparation of higher iodides.—An examination of the products obtained by the dry distillation of bran with lime. Preliminary communication, by W. F. Laycock and F. Klingemann. On distilling a mixture of bran and quick-lime, a black oil, floating on an aqueous solution is obtained. The aqueous solution smells of herring brine, contains much ammonia, and on boiling evolves inflammable gases. The oil is evidently a complex mixture, and has not yet been separated into its constituents.—The atomic weight of palladium, by G. H. Bailey and T. Lamb.—The action of sulphuryl chloride on acetorthotoluidide and acetparatoluidide, by W. P. Wynne.

PARIS.

Academy of Sciences, July 18.—M. d'Abbadie in the chair.—On a slight additive correction which may have to be applied to the heights of water indicated by sea-gauges, when the swelling or chopping agitation of the sea reaches a great intensity: case of a choppy sea, by M. J. Boussinesq. In this second case the correction is much smaller than in the former, amounting to not more than 0·1 mm. in an extreme case.—Preparation and properties of proto-iodide of carbon, by M. Henri Moissan. If an exhausted sealed tube containing crystals of the tetra-iodide of carbon be heated in an oil bath to 120°, iodine is liberated and condenses in the cooler portion of the tube, while less volatile crystals of the proto-iodide of carbon are produced, corresponding to the formula C_2I_4. To obtain greater quantities, the tetra-iodide is reduced by silver powder. The substance obtained presents itself in beautiful pale yellow crystals of density 4·38, fusing at 185°, and volatile without decomposition below their point of fusion. By slow volatilization in a vacuum at a temperature between 100° and 120°, transparent crystals are produced, some of which form highly refracting hexagonal tablets. The proto-iodide is very soluble in carbon bisulphide, tetrachloride, and ordinary ether, which, by cooling, gives good crystals. The new compound is very stable, being not oxidized by potassium permanganate, and boiling chromic and nitric acids.—On one of the reactions of spermine, by M. Duclaux.—On a fossil baboon of the quaternary phosphorites of Algeria, *Macacus trarensis*, by M. A. Pomel.—Project of meteorological observatories on the Atlantic Ocean by Albert I., Prince of Monaco. A proposal to establish a station on the Azores as soon as the projected cable is laid, and also on Madeira, the Canaries, Bermuda, and the Peak of Teneriffe. It is expected that the prediction of cyclones will be much facilitated, and Monaco is suggested as a centre for the collection and distribution of the information obtained.—On the specific heat and the latent heat of fusion of aluminium, by M. J. Pionchon. The total quantity of heat required to raise 1 gr. of aluminium from 0° to its fusing point, 625°, is 239·4. The latent heat of fusion is very large, being equal to that of water, viz., 80 cal.—On the measurement of the dielectric constant, by M. A. Perot. The further value obtained for glass was 2·39, which, obtained by means of a glass prism weighing 65 kg., agrees very well with that obtained from very rapid oscillations. The values obtained by these two methods, being unaffected by residual charges, are more reliable than those derived from the static, the attraction, and the ballistic galvanometer methods.—On the principle of maximum work, by M. H. Le Chatelier. An examination of the bearing of certain thermodynamic laws on Berthelot's principle, showing that the contradiction between them is only apparent.—On a basic nitrate of calcium, by M. A. Werner.—On the efflorescence of sulphate of copper and some other metallic sulphates, by MM. H. Baubigny and E. Pechard.—On the decomposition of the basic nitrates by water, by MM. G. Rousseau and G. Tite.—On phosphopalladic combinations, by M. E. Fink.—On the mechanical contrast between the radical cyanogen and the chloroid elements, by M. G. Hinrichs.—The influence of the substitution of the methyl group for one benzene hydrogen on the properties of orthotoluidine, by M. A. Rosenstiehl.—On the instability of the carboxyl in the phenol acids, by M. P. Cazeneuve.—On preserved ferruginous mineral waters, by M. J. Riban.—On a new leucomaine, by M. A. B. Griffiths.—Effects of sudden release on animals placed in compressed air, by M. G. Philippon. It was found that although rabbits subjected to a pressure of six or eight atmospheres were unaffected if the pressure was gradually released, a sudden expansion was followed by almost instantaneous death. The cause of death appears to be the mechanical expansion of the gas contained in the vessels, which, in the case of gradual release, is eliminated by the lungs in a few minutes.—On the immediate reparation of losses of intra-osseous substances, with the aid of aseptic bodies, by MM. S. Duplay and M. Cazin.—The coxal gland of the scorpion and its morphological relations to the excretory glands of the Crustacea, by M. Paul Marchal.—The avalanche of the Têtes-Rousses. Catastrophe of St. Gervais-les-Bains (Haute-Savoie), by M. F. A. Forel.—On certain forms of filling-up observed in some lakes of the Pyrenees, by M. Emile Belloc.

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THURSDAY, AUGUST 4, 1892.

COAL-TAR COLOURING-MATTERS.

Tabellarische Uebersicht der künstlichen organischen Farbstoffe. Von Gustav Schultz und Paul Julius. R. Gaertner's Verlagsbuchhandlung, Hermann Heyfelder. (Berlin, 1891.)

DR. SCHULTZ is well known to "tar chemists" as the author of "Die Chemie des Steinkohlentheers," the most exhaustive work on coal-tar products which has hitherto been written, and of which the first edition appeared in 1882, and the second, enlarged to two thick volumes, in 1887–1890. His colleague Dr. Julius is the author of a useful little work on the same subject published in 1887. The volume before us is a remarkable production from every point of view, and well worthy of the reputation of the two authors who have collaborated in its production. Although nothing more than a tabulated catalogue of coal-tar colouring-matters, as it professes to be, the work is in reality a complete index to the literature of this rapidly growing branch of industry; complete, that is to say, to the date of its publication; but development is taking place even now at such a pace that a single year has sufficed to render a supplement necessary, and many of the most recently added colouring-matters are not included in the lists. The first edition of the "Tabellarische Uebersicht" was published in 1888 and contained 278 colouring-matters; the present edition contains 392 colouring-matters—a fact which speaks for itself with respect to the progress of chemical discovery in this direction. The volume is dedicated to the late Prof. von Hofmann, whose labours in this field in the early days of the industry will render his name inseparable from that band of pioneers who were the first to penetrate into the new regions opened up by the discovery of mauve by Dr. W. H. Perkin in 1856.

The volume of tables under consideration has become indispensable to every chemist engaged in the manufacture of, or in any way interested in, the coal-tar colouring-matters. To the general chemist it will be a matter of wonder that from three to four hundred distinct compounds, for the most part of known constitution, definite in character, often beautiful in crystalline form and appearance, and, in short, all well-characterised "chemical individuals," should be turned out of factories by hundredweights and tons for consumption in the tinctorial industries.

The authors group the colouring-matters under sixteen headings:—Nitro-derivatives, Azoxy-compounds, Hydrazones, Azo-compounds, Nitroso-compounds (quinone-oximes), Oxyketones, Diphenyl-methane derivatives, Triphenyl methane derivatives, Indophenols, Oxazines and Thiazines, Azines, Artificial Indigo, Quinoline colouring-matters, Acridine colouring-matters, Thiobenzenyl derivatives, and colouring-matters of unknown constitution. The tables are arranged in eight columns, the first containing the commercial name of the colouring-matter, the second its scientific name, the third its empirical formula, the fourth its constitutional formula, the fifth its mode of preparation, the sixth its date of discovery, the seventh the name of the discoverer and literary references, and the eighth its general properties and mode of application. From this analysis it will be seen that the work is, as we have stated, a complete epitome of the coal-tar colour industry. Its value as a work of reference for technologists will be appreciated by all who may have occasion to consult it; our own experience has been that the many thousand references to chemical literature, patents, and periodicals, are given with an accuracy that leaves nothing to be desired. One special feature to which attention must be directed is that the compounds tabulated are or have been actual articles of commerce. If the colouring-matter has been superseded, as must inevitably be the case with the progress of discovery, the authors announce the fact by stating *nicht mehr im Handel*. Thus the reader is made acquainted with the actual state of the industry, and the student with these tables at hand will be prevented from becoming a prey to the snares of the compilers of examinational text-books, who are only too frequently quite out of touch with the technology of their subject. Writers of this class are apt to set forth lists of compounds which are worthless to the manufacturer, and which are of value only to the examiner in technology by enabling him at once to separate the sheep from the goats among his candidates—to distinguish the students whose knowledge has been derived solely from books from those who are actually engaged in the factory.

One very forcible truth which is brought home on running the eye down the seventh column of the tables before us is the great preponderance of references to patents, chiefly German. It is evident that the chemist who wishes to keep abreast of modern discovery can no longer afford to neglect the literature of the Patent Office. Many discoveries of the greatest scientific importance are buried in these specifications, and it is long before they find their way into the text-books. This, so far as we are concerned, is much to be regretted, for, in the first place, the working chemist is already painfully overburdened with literature, and in the next place the statements in specifications require very judicious sifting before they can be admitted as part of scientific knowledge. The student who is not familiar with the coal-tar colour industry would be hopelessly entangled among the mazes of patent literature were it not for such practical guides as Drs. Schultz and Julius, who have evidently used the greatest judgment in giving their references. In other words, the patents quoted have reference to the production of compounds which are, or were, manufactured, and the reader who consults their work may feel assured that the "bogus" or "fishing" patent, which may be so innocently swallowed by the unwary, will not be obtruded on his notice.

So far as English technologists are concerned, it is to be regretted that such an overwhelming majority of German patents have to be referred to. This, of course, is only to be expected, when we consider the extraordinary activity which the Germans have displayed in the development of the industry of which the foundations were laid in this country about thirty or forty years ago. But the technological student is thereby placed at a disadvantage because German patents are not very readily obtainable. It is true that all capital discoveries are also patented in this country, but, on the other hand, there are many important chemical processes discovered and patented on the Continent which are not filed in our Patent Office, and which are so long in finding their way into the current literature that they are apt to be overlooked. Chemists who have occasion to consult the admirable series of tables by Schultz and Julius cannot but look with admiration—even if tinged with envy—at the brilliant series of discoveries which have emanated from the laboratories of German universities, technical schools, and factories. This is the fruit of technical education in the true sense ; no system of cramming for an examination, no method of orthodox "test-tubing," not even the "recreative institute" line of technical training, which is so much in vogue at the present time, will enable us to recover our lost position in this or in any other branch of chemical technology.

R. MELDOLA.

RAM BRAMHA SÁNYÁL ON THE MANAGEMENT OF ANIMALS IN CAPTIVITY.

A Handbook on the Management of Animals in Captivity in Lower Bengal. By Ram Bramha Sányál, Superintendent of the Zoological Garden, Calcutta. (Calcutta, 1892.)

CONSIDERING the number of zoological gardens in Europe, and their long establishment, it is singular that it should have been left to the superintendent of a zoological garden at Calcutta, and to a native of India withal, to produce the first practical handbook on the management of animals in captivity. The author, who, we believe, is a member of the "Brahma Somaj," and one of the very few natives of British India that have exhibited any taste for natural history, has been for some years superintendent of the Zoological Garden at Calcutta, an excellent institution mainly kept up by the Government of Bengal, but under the control of a committee of the subscribers. This committee, at the suggestion of Sir Steuart Bayley, the Lieutenant-Governor of Bengal, came to the conclusion that, after thirteen years' experience of the management of animals, it might be possible to produce a handbook on the subject which "would be of interest to the scientific world," and at the same time "of great use to nobles and other persons who, on a smaller scale, keep a collection of animals in captivity."

Such was the origin of the present volume, which has been prepared by Babu Ram Bramha Sányál, on a plan drawn up by a sub-committee appointed for the purpose, and has been supervised by Mr. C. E. Buckland, C.S., who was at one time honorary secretary to the Calcutta Garden, and is now a member of the Council of the Zoological Society of London. It is certainly a work of considerable interest. In the first place it has the merit of giving us a complete classified list of all the mammals and birds that have been kept alive in the Calcutta Garden. These are, of course, mostly species of British India—241 of the class of mammals, and 402 birds—but there are a good many exotic forms among the birds. In the second place large numbers of notes on the treatment of the animals in health and in sickness, on their length of life in captivity, and generally on their habits as observed in confinement are introduced, which, although in some cases of an apparently trifling nature, are well worthy of study by those who are engaged in the custody of living animals. It is evident that the author has kept a regular journal, and has recorded his experiences very minutely. In a case of a fight between a lioness and a tiger, which were by some accident allowed to pass into the same compartment of the Carnivora house, the tiger was completely victorious and killed the lioness. The longest period during which a tiger has lived in the Calcutta Gardens is fourteen years. It is curious that the Lesser Fruit-bat of Bengal (*Cynopterus marginatus*) "does not appear to bear captivity well." A nearly allied African species (*C. collaris*) has completely established itself in our Regent's Park Garden, and has bred abundantly for the last twenty years. On January 30, 1889, a young rhinoceros was born in the Calcutta Gardens, "the second recorded instance" of this mammal having bred in captivity. Interesting details are given of this event. The parents were a male Sumatran rhinoceros and a female of the northern form of the same species, which has been separated as *Rhinoceros lasiotis*. The highest bliss of these animals, as the Babu points out, is to "lie undisturbed in a muddy hollow," besmeared with liquid dirt.

In 1886 the Calcutta Garden obtained from Dar-es-Salam, in Eastern Africa, a young hippopotamus, but it did not live for more than eighteen months. Probably its voyage from Zanzibar to Calcutta "in an ordinary box without water" materially affected its health, as the hippopotamus, if properly treated, does exceedingly well in captivity.

The authorities of the Calcutta Garden have not yet succeeded in keeping the pangolin alive for any lengthened period. The same has been the case in our Zoological Gardens, where, although several examples of this Edentate have been received, not one has survived many weeks. This is curious, as both the American ant-eater (*Myzmecophaga*) and the African ant-bear (*Orycteropus*) maintain excellent health in captivity. It is suggested that the difficulty of obtaining a supply of their proper food—the *termites*—is the cause of this failure. At the same time, when supplies of this insect have been placed within reach the Pangolin has been "known to take no notice of them." We cannot therefore suppose that the true solution of this difficulty has yet been hit upon. It may be stated that in a similar manner ant-eaters kept in this country will not eat ants, but thoroughly enjoy raw meat when minced up small in a sausage machine.

The second part of the handbook contains a list of the birds exhibited in the Calcutta Garden, and corresponding observations upon them, but naturally there is not so much to be said on this branch of the subject. Among the more interesting species of this order we notice the fine large Laughing-thrush of the Himalayas (*Garrulax leucolophus*), the gold-fronted chloropsis (*Chloropsis aurifrons*), several sorts of drongo (*Dicruridæ*), Gould's ouzel (*Merula gouldi*), and the pheasant-tailed jacana (*Hydrophasianus chirurgus*), all birds which are rarely, if ever, seen in European aviaries. On the whole we must allow that this volume is a remarkable production, considering the circumstances under which it has been prepared, and that its author deserves great credit for the pains bestowed on its composition, and for much valuable information contained in it.

OUR BOOK SHELF.

In Starry Realms. By Sir Robert S. Ball, D.Sc., LL.D., F.R.S. (London: Isbister and Co., 1892.)

THIS is another striking example of Sir Robert Ball's skill in popularizing the most fascinating of the sciences. Though the same story has been to a large extent told by him before, there are several new features which prevent the least suspicion of staleness. The author is perhaps most interesting in his homely illustrations of astronomical dimensions. Among these are the disc of the moon projected on the map of Europe, and three lunar craters similarly compared with the map of England. The history of a falling star, as told by a particularly intelligent meteorite, is also worth special notice.

The two final chapters consist of "An Astronomer's Thoughts about Krakatoa," and "Darwinism in its Relation to other Branches of Science." The former is a popular account of the Report of the Krakatoa Committee of the Royal Society. The moral of the last chapter is that the scientific method of Darwin is closely related to that employed in astronomy. "Astronomers were the first evolutionists: they had sketched out a majestic scheme of evolution for the whole solar system, and now they are rejoiced to find that the great doctrine of Evolution has received an extension to the whole domain of organic life by the splendid genius of Darwin" (p. 349). We can confidently recommend the book to all classes of readers. Those who are already familiar with the subject will find much to delight them.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Basset's Physical Optics.

I DESIRE to make a few remarks on Prof. Schuster's review of my treatise on physical optics.

The sentence in the preface to which he refers is not perhaps very happily arranged, and might be amended as follows:—

"I have a profound distrust of arguments based upon vague and obscure general reasoning instead of upon rigorous mathematical analysis." This, however, is a small matter; what I wished to protest against was, the practice which has crept into more than one recent work, of slurring over an investigation by means of a page or two of general talk, instead of writing out a careful mathematical demonstration; or at any rate making a serious attempt to grapple with mathematical difficulties, and trying to arrive at a definite result.

I fully admit, that when a subject is in a state of growth it is often impossible to dispense with hypothesis. But whenever this is necessary, the hypothesis should be expressed in clear and definite language; the evidence and arguments for and against the hypothesis should be properly marshalled and discussed; the reader should be plainly informed that the proposition which forms the basis of the investigation is a hypothesis and not an established fact, and that consequently further research may show that the hypothesis must either be abandoned or modified. When an investigation is conducted on these lines, all obscurity and vagueness will be avoided; for the reader will be thereby enabled to clearly understand the exact nature of the assumptions which are made, and will be able to discriminate between those portions of the investigation which consist of hypothesis, and those which constitute results deduced from hypothesis by the aid of mathematical analysis.

The dangerous character of arguments based upon general reasoning is well illustrated by the theory of the deformation of thin elastic plates and shells. When a thin shell is deformed by means of bodily forces, and stresses applied to its edges, the effect produced is extension, change of curvature, and torsion; and it might be argued from this, that the potential energy due to deformation is a homogeneous quadratic function of the quantities by which extension, change of curvature, and torsion are specified. But if the expressions for the potential energy of a cylindrical or of a spherical shell be examined (Phil. Trans. 1890, pp. 443, 467), it will be found that they contain certain terms which involve the *differential coefficients* of quantities by which extension is specified.

With regard to the concluding portion of the review, I must point out that one of the difficulties with which the author of an advanced treatise is confronted is *where to draw the line.* Upon this subject there is necessarily room for a wide difference of opinion. As my object was to write a book on physical optics, I considered that the reader might properly be expected to obtain his information respecting the various theories of the electromagnetic field, from the treatises and original memoirs on that subject; and for that reason I abstained from discussing purely electromagnetic theories, further than was necessary for the explanation of optical phenomena. A. B. BASSET.

July 25.

Causes of the Deformation of the Earth's Crust.

THE communication from E. Reyer in NATURE of July 7 (p. 224) "On the Causes of the Deformation of the Earth's Crust" is interesting from several points of view. It is an indication that the theory which looks upon mountain ranges as the effects of the earth's contraction does not satisfy the conditions of the geologist.

It is welcome to me individually as in the main accepting the principles of which I happen to be the exponent, and have systematized in the "Origin of Mountain Ranges," published in 1886. It is, however, the addition to this theory explaining the folding of strata by what Mr. Reyer aptly calls "gliding" that calls for examination. It is shown very clearly by experiment and otherwise that under certain conditions strata, when they reach a certain degree of inclination on the flanks of a mountain chain during elevation, must glide downwards by gravitation and produce folds and disturbances towards the lowlands. We have only to consider the effects of land-slides such as occur in the chalk districts in the south of England, and their effects on the shore deposits, to admit the truth of this. This aspect of the problem, though always present, has grown on me since my work was published, and I have little doubt that the "foot-hills" usually formed of the newer strata which flank most great mountain ranges are to a considerable extent due to gravitation and "gliding." I may point to the foot-hills of the Canadian Rockies and of the Himálayas as illustrations. The cases of folded lying upon undisturbed strata mentioned by Reyer are, as he clearly shows, explanatory on this view, but not by general contraction.

There are no doubt other effects traceable to the gravitation of masses of the earth's crust during elevation such as the lateral spreading of the plastic cores of mountain ranges in fan-like form, and the consequent shouldering of the strata on either side intensifying the effects of the folding of the strata by thermal expansion, as explained in the "Origin of Mountain Ranges."

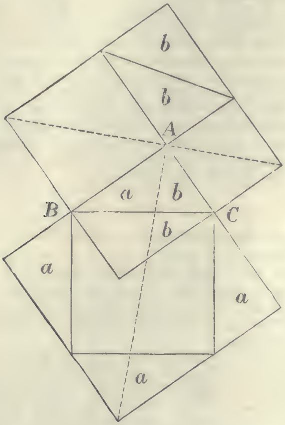
I cannot, however, follow Mr. Reyer if he considers "gliding" an explanation of all folding. I am not sure that this is his meaning, though the last paragraph would seem to bear such an interpretation. It seems obvious to me, to mention only one of numerous examples, viz., the folds of Jurassic strata caught up in the gneiss of the Central Alps, as shown in Heim's section, reproduced in "Prestwich's Geology," and in plate xiv., "Origin of Mountain Ranges."

While looking upon "gliding" as only a partial explanation of folding, I welcome Mr. Reyer's fresh and vigorous treatment of the important problem of the causes of the deformation of the earth's crust. It is evidence that geologists and physicists are now allowing their minds to play freely round the subject of the orogenic changes of the earth's crust, and of the growth of philosophical conceptions on the geological evolution of our planet.

Park Corner, Blundellsands, T. MELLARD READE.
July 11.

An Obvious Demonstration of the 47th Proposition of Euclid.

SOME years ago in trying for a simpler demonstration of this theorem I worked out the following. Its extreme simplicity suggested that it could scarcely be original; but as some years have elapsed, and as none of my friends have seen it elsewhere, I send it to you as possibly of interest to some and perhaps of use where practical geometry is being taught. It is evident that the two larger squares are equal, the side of each being equal to the sum of the sides AB, AC of the triangle ABC. It is also clear that the four triangles marked "*a*" are equal to one another. Again, the four triangles marked "*b*" are equal to one another, and to the four triangles marked "*a*."



Hence taking four times the triangle "*a*" from one of the large squares and four times triangle "*b*" from the other, there remain in the one case the square on BC, and in the other case the squares on AB and AC, and these remainders are equal. Therefore the square on the hypothenuse is equal to the sum of the squares on the other two sides.

A. J. BICKERTON.

Canterbury College, New Zealand University,
June 15.

[The principle of the above solution is not new. A proof, by dissection, depending on it is given in several text-books. The novelty of it consists in the position of the squares by means of which the truth of the property is seen in one figure.]

Musical Sand. Lava in the Bournemouth Drift.

IN reference to the note in NATURE (July 21) respecting musical sand in Australia, permit me to say that the subject has long since received attention there. I am away from references at present, but I should think it must be over two years since Mr. Sidney Olliff kindly sent me samples from Botany Bay. The samples sent were enclosed in small canvas bags, and, though there was probably not more than half-an-ounce of each, they were very musical on reaching me. For purity and musical effect, the Botany Bay samples were more like the Eigg sand than any other kinds I had previously examined.

During the last five years I have been collecting the various kinds of rock found in the Bournemouth high-level gravels (Codrington). A section has lately been exposed at the head of Alum Chine. Here a bed of angular and sub-angular flint gravel 5 ft. (varying) in thickness rests on the Bagshots, and is covered by sand, humus, and peat. At the base of the gravel bed I disinterred (on the 17th inst.) a small piece of vesicular lava, much decomposed in places, but retaining more than sufficient of its original structure for purposes of identification.

The specimen will be sliced for the microscope; in the meantime I draw attention to it because it is, to my knowledge, the first specimen of vesicular lava that has been found in these gravels. CECIL CARUS-WILSON.

Oxford, July 27.

The Flora and Fauna of Bromley.

THE Bromley Naturalists' Society have recently appointed a Special Committee to draw up lists of the flora and fauna of the Bromley Union District. This district comprises the parishes of Beckenham, Bromley, Chelsfield, Chislehurst, Cudham, Down, Farnborough, Foots Cray, Hayes, Keston, Knockholt, Mottingham, North Cray, Orpington, St. Mary Cray, St. Paul's Cray, and West Wickham.

I am desired to ask you to allow me to state that the Special Committee will be glad to receive from your readers any information which in their opinion might be of service to the Committee. J. FRENCH.

Hon. Sec. Special Committee.

99, Widmore-road, Bromley, Kent, July 27.

THE BRITISH ASSOCIATION.

EDINBURGH.

AN Edinburgh meeting of the British Association seems almost a home meeting. At every turn we are reminded of some of those who bore their part in founding and building up the Parliament of Science. Sir David Brewster meets us in the University quadrangle. The chair now set apart for the President of Section A was occupied for many years by James David Forbes, while for one brief year Natural History in Edinburgh was identified with Edward Forbes, to whom the Association owes, among many greater things, the evolution of the Red Lion. Viewed through the vista of years, the intellectual life of Edinburgh seems to have been marked by the combination of the love of science and letters with the full enjoyment of social intercourse, and we have before us such evidence of the persistence of this trait as bodes well for the success of the meeting.

The reception rooms are in keeping with the dignity of the Association, and afford every facility for the transaction of business. The programme of local arrangements which has been put in the hands of members indicates ample variety of occupation for hours of leisure. This pamphlet is of convenient size and easy of reference. In one point of detail it is worthy of remark; its maps do not require to be unfolded; these are two, one showing clearly, although on a small scale, Edinburgh and its suburbs, and the other giving, on a large scale, the part of the city which will be most frequently traversed by visitors. The Excursion Handbook has evidently been compiled with much care, and it will prove an interesting and artistic souvenir of the meeting.

Sir Archibald Geikie, the President of the Association, was President of the Geological section at the 1871 Edinburgh meeting. His address, suggested by the centenary of Hutton's "Theory of the Earth," deals with a subject in which Scottish geologists have ever been well to the front. The last decade of geological work in Scotland has done much to unlock the secrets of rock structure, and there could be no more fit exponent of the results than the president.

In the section programmes we hear promise of many welcome papers and several important discussions; in Section A, on Monday, the question of a National Physical Laboratory will be dealt with; while Tuesday will be devoted to a discussion on electrical units, in this Prof. von Helmholtz is expected to take part; Section B and D will consider bacteriology, with special reference to Brewing; Section D, "Fisheries"; Section F, "Old Age Pensions." In Section C, the feature of the meeting is likely to be the review of recent work in the geology of Scotland, and the presence of a considerable number of foreign geologists is sure to lead to interesting discussions. The Prince of Monaco will give in Section E the results of his observations on ocean currents. Section G will this year devote some attention to the subject on which there is much difference of opinion, the education of engineers.

Inaugural Address by Sir Archibald Geikie, LL.D., D.Sc., For.Sec.R.S., F.R.S.E., F.G.S., Director-General of the Geological Survey of the United Kingdom, President.

In its beneficent progress through these islands the British Association for the Advancement of Science now for the fourth time receives a welcome in this ancient capital. Once again, under the shadow of these antique towers, crowded memories of a romantic past fill our thoughts. The stormy annals of Scotland seem to move in procession before our eyes as we walk these streets, whose names and traditions have been made familiar to the civilized world by the genius of literature. At every turn, too, we are reminded, by the monuments which a grateful city has erected, that for many generations the pursuits which we are now assembled to foster have had here their congenial home. Literature, philosophy, science, have each in turn been guided by the influence of the great masters who have lived here, and whose renown is the brightest gem in the chaplet around the brow of this "Queen of the North."

Lingering for a moment over these local associations, we shall find a peculiar appropriateness in the time of this renewed visit of the Association to Edinburgh. A hundred years ago a remarkable group of men was discussing here the great problem of the history of the earth. James Hutton, after many years of travel and reflection, had communicated to the Royal Society of this city, in the year 1785, the first outlines of his famous "Theory of the Earth." Among those with whom he took counsel in the elaboration of his doctrines were Black, the illustrious discoverer of "fixed air" and "latent heat"; Clerk, the sagacious inventor of the system of breaking the enemy's line in naval tactics; Hall, whose fertile ingenuity devised the first system of experiments in illustration of the structure and origin of rocks; and Playfair, through whose sympathetic enthusiasm and literary skill Hutton's views came ultimately to be understood and appreciated by the world at large. With these friends, so well able to comprehend and criticize his efforts to pierce the veil that shrouded the history of this globe, he paced the streets amid which we are now gathered together; with them he sought the crags and ravines around us, wherein Nature has laid open so many impressive records of her past; with them he sallied forth on those memorable expeditions to distant parts of Scotland, whence he returned laden with treasures from a field of observation which, though now so familiar, was then almost untrodden. The centenary of Hutton's "Theory of the Earth" is an event in the annals of science which seems most fittingly celebrated by a meeting of the British Association in Edinburgh.

In choosing from among the many subjects which might properly engage your attention on the present occasion, I have thought that it would not be inappropriate nor uninteresting to consider the more salient features of that "Theory," and to mark how much in certain departments of inquiry has sprung from the fruitful teaching of its author and his associates.

It was a fundamental doctrine of Hutton and his school that this globe has not always worn the aspect which it bears at present; that, on the contrary, proofs may everywhere be culled that the land which we now see has been formed out of the wreck of an older land. Among these proofs the most obvious are supplied by some of the more familiar kinds of rock, which teach us that, though they are now portions of the dry land, they were originally sheets of gravel, sand, and mud, which had been worn from the face of long-vanished continents, and after being spread out over the floor of the sea, were consolidated into compact stone, and were finally broken up and raised once more to form part of the dry land. This cycle of change involved two great systems of natural processes. On the one hand, men were taught that by the action of running water the materials of the solid land are in a state of continual decay and transport to the ocean. On the other hand, the ocean-floor is liable from time to time to be upheaved by some stupendous internal force akin to that which gives rise to the volcano and the earthquake. Hutton further perceived that, not only had the consolidated materials been disrupted and elevated, but that masses of molten rock had been thrust upward among them, and had cooled and crystallized in large bodies of granite and other eruptive rocks which form so prominent a feature on the earth's surface.

It was a special characteristic of this philosophical system that it sought in the changes now in progress on the earth's surface an explanation of those which occurred in older times. Its founder refused to invent causes or modes of operation, for those with which he was familiar seemed to him adequate to solve the problems with which he attempted to deal. Nowhere was the profoundness of his insight more astonishing than in the clear, definite way in which he proclaimed and reiterated his doctrine, that every part of the surface of the continents, from mountain-top to sea-shore, is continually undergoing decay, and is thus slowly travelling to the sea. He saw that no sooner will the sea-floor be elevated into new land than it must necessarily become a prey to this universal and unceasing degradation. He perceived that, as the transport of disintegrated material is carried on chiefly by running water, rivers must slowly dig out for themselves the channels in which they flow, and thus that a system of valleys, radiating from the water-parting of a country, must necessarily result from the descent of the streams from the mountain crests to the sea. He discerned that this ceaseless and widespread decay would eventually lead to the entire demolition of the dry land; but he contended that from time to time this catastrophe is prevented by the operation of the underground forces, whereby new continents are upheaved from the bed of the ocean. And thus in his system a due proportion is maintained between land and water, and the condition of the earth as a habitable globe is preserved.

A theory of the earth so simple in outline, so bold in conception, so full of suggestion, and resting on so broad a base of observation and reflection, ought, we might think, to have commanded at once the attention of men of science, even if it did not immediately awaken the interest of the outside world; but, as Playfair sorrowfully admitted, it attracted notice only very slowly, and several years elapsed before any one showed himself publicly concerned about it, either as an enemy or a friend. Some of its earliest critics assailed it for what they asserted to be its irreligious tendency—an accusation which Hutton repudiated with much warmth. The sneer levelled by Cowper a few years earlier at all inquiries into the history of the universe was perfectly natural and intelligible from that poet's point of view. There was then a widespread belief that this world came into existence some six thousand years ago, and that any attempt greatly to increase that antiquity was meant as a blow to the authority of Holy Writ. So far, however, from aiming at the overthrow of orthodox beliefs, Hutton evidently regarded his "Theory" as an important contribution in aid of natural religion. He dwelt with unfeigned pleasure on the multitude of proofs which he was able to accumulate of an orderly design in the operations of nature, decay and renovation being so nicely balanced as to maintain the habitable condition of the planet; but as he refused to admit the predominance of violent action in terrestrial changes, and on the contrary contended for the efficacy of the quiet, continuous processes which we can even now see at work around us, he was constrained to require an unlimited duration of past time for the production of those revolutions of which he perceived such clear and abundant proofs in the crust of the earth. The general public, however, failed to comprehend that the doctrine of the high antiquity of the globe was not inconsistent with the comparatively recent appearance of man—a distinction which seems so obvious now.

Hutton died in 1797, beloved and regretted by the circle of friends who had learnt to appreciate his estimable character and to admire his genius, but with little recognition from the world at large. Men knew not then that a great master had passed away from their midst, who had laid broad and deep the foundations of a new science; that his name would become a household word in after generations, and that pilgrims would come from distant lands to visit the scenes from which he drew his inspiration.

Many years might have elapsed before Hutton's teaching met with wide acceptance, had its recognition depended solely on the writings of the philosopher himself. For, despite his firm grasp of general principles and his mastery of the minutest details, he had acquired a literary style which, it must be admitted, was singularly unattractive. Fortunately for his fame, as well as for the cause of science, his devoted friend and disciple, Playfair, at once set himself to draw up an exposition of Hutton's views. After five years of labour on this task there appeared the classic "Illustrations of the Huttonian Theory," a work which for luminous treatment and graceful diction stands still without a rival in English geological literature. Though professing merely to set forth his friend's doctrines, Playfair's treatise was in many respects an original contribution to science of the highest value. It placed for the first time in the clearest light the whole philosophy of Hutton regarding the history of the earth, and enforced it with a wealth of reasoning and copiousness of illustration which obtained for it a wide appreciation. From long converse with Hutton, and from profound reflection himself, Playfair gained such a comprehension of the whole subject that, discarding the non-essential parts of his master's teaching, he was able to give so lucid and accurate an exposition of the general scheme of Nature's operations on the surface of the globe, that with only slight corrections and expansions his treatise may serve as a text-book to-day. In some respects, indeed, his volume was long in advance of its time. Only, for example, within the present generation has the truth of his teaching in regard to the origin of valleys been generally admitted.

Various causes contributed to retard the progress of the Huttonian doctrines. Especially potent was the influence of the teaching of Werner, who, though he perceived that a definite order of sequence could be recognized among the materials of the earth's crust, had formed singularly narrow conceptions of the great processes whereby that crust has been built up. His enthusiasm, however, fired his disciples with the zeal of proselytes, and they spread themselves over Europe to preach everywhere the artificial system which they had learnt in Saxony. By a curious fate Edinburgh became one of the great headquarters of Wernerism. The friends and followers of Hutton found themselves attacked in their own city by zealots who, proud of superior mineralogical acquirements, turned their most cherished ideas upside down and assailed them in the uncouth jargon of Freiberg. Inasmuch as subterranean heat had been invoked by Hutton as a force largely instrumental in consolidating and upheaving the ancient sediments that now form so great a part of the dry land, his followers were nicknamed Plutonists. On the other hand, as the agency of water was almost alone admitted by Werner, who believed the rocks of the earth's crust to have been chiefly chemical precipitates from a primeval universal ocean, those who adopted his views received the equally descriptive name of Neptunists. The battle of these two contending schools raged fiercely here for some years, and though mainly from the youth, zeal, and energy of Jameson, and the influence which his position as Professor in the University gave him, the Wernerian doctrines continued to hold their place, they were eventually abandoned even by Jameson himself, and the debt due to the memory of Hutton and Playfair was tardily acknowledged.

The pursuits and the quarrels of philosophers have from early times been a favourite subject of merriment to the outside world. Such a feud as that between the Plutonists and Neptunists would be sure to furnish abundant matter for the gratification of this propensity. Turning over the pages of Kay's "Portraits," where so much that was distinctive of Edinburgh's society a hundred years ago is embalmed, we find Hutton's personal peculiarities and pursuits touched off in good-humoured caricature. In one plate he stands with arms folded and hammer in hand, meditating on the face of a cliff, from which rocky prominences in shape of human faces, perhaps grotesque likenesses of his scientific opponents, grin at him. In another engraving he sits in conclave with his friend Black, possibly arranging for that famous banquet of garden-snails which the two worthies had persuaded themselves to look upon as a strangely neglected form of human food. More than a generation later, when the Huttonists and Wernerists were at the height of their antagonism, the humorous side of the controversy did not escape the notice of the author of "Waverley," who, you will remember, when he makes Meg Dods recount the various kinds of wise folk brought by Lady Penelope Pennfeather from Edinburgh to St. Ronan's Well, does not forget to include those who "rin uphill and down dale, knapping the chucky-stanes to pieces wi' hammers, like sae mony road-makers run daft, to see how the warld was made."

Among the names of the friends and followers of Hutton there is one which on this occasion deserves to be held in especial honour, that of Sir James Hall, of Dunglass. Having accompanied Hutton in some of his excursions, and having discussed with him the problems presented by the rocks of Scotland, Hall was familiar with the views of his master, and was able to supply him with fresh illustrations of them from different parts of the country. Gifted with remarkable originality and ingenuity, he soon perceived that some of the questions involved in the theory of the earth could probably be solved by direct physical experiment. Hutton, however, mistrusted any attempt "to judge of the great operations of Nature by merely kindling a fire and looking into the bottom of a little crucible." Out of deference to this prejudice Hall delayed to carry out his intention during Hutton's lifetime. But afterwards he instituted a remarkable series of researches which are memorable in the history of science as the first methodical endeavour to test the value of geological speculation by an appeal to actual experiment. The Neptunists, in ridiculing the Huttonian doctrine that basalt and similar rocks had once been molten, asserted that, had such been their origin, these masses would now be found in the condition of glass or slag. Hall, however, triumphantly vindicated his friend's view by proving that basalt could be fused, and thereafter by slow cooling could be made to resume a stony texture. Again, Hutton had asserted that under the vast pressures which must be effective deep within the earth's crust, chemical reactions must be powerfully influenced, and that under such conditions even limestone may conceivably be melted without losing its carbonic acid. Various specious arguments have been adduced against this proposition, but by an ingeniously devised series of experiments, Hall succeeded in converting limestone under great pressure into a kind of marble, and even fused it, and found that it then acted vigorously on other rocks. These admirable researches, which laid the foundations of experimental geology, constitute not the least memorable of the services rendered by the Huttonian school to the progress of science.

Clear as was the insight and sagacious the inferences of these great masters in regard to the history of the globe, their vision was necessarily limited by the comparatively narrow range of ascertained fact which up to their time had been established. They taught men to recognize that the present world is built of the ruins of an earlier one, and they explained with admirable perspicacity the operation of the processes whereby the degradation and renovation of land are brought about. But they never dreamed that a long and orderly series of such successive destructions and renewals had taken place, and had left their records in the crust of the earth. They never imagined that from these records it would be possible to establish a determinate chronology that could be read everywhere, and applied to the elucidation of the remotest quarter of the globe. It was by the memorable observations and generalizations of William Smith that this vast extension of our knowledge of the past history of the earth become possible. While the Scottish philosophers were building up their theory here, Smith was quietly ascertaining by extended journeys that the stratified rocks of the West of England occur in a definite sequence, and that each well-marked group of them can be discriminated from the others and identified across the country by means of its enclosed organic remains. It is nearly a hundred years since he made known his views, so that by a curious coincidence we may fitly celebrate on this occasion the centenary of William Smith as well as that of James Hutton. No single discovery has ever had a more momentous and far-reaching influence on the progress of a science than that law of organic succession which Smith established. At first it served merely to determine the order of the stratified rocks of England. But it soon proved to possess a world-wide value, for it was found to furnish the key to the structure of the whole stratified crust of the earth. It showed that within that crust lie the chronicles of a long history of plant and animal life upon this planet, it supplied the means of arranging the materials for this history in true chronological sequence, and it thus opened out a magnificent vista through a vast series of ages, each marked by its own distinctive types of organic life, which, in proportion to their antiquity, departed more and more from the aspect of the living world.

Thus a hundred years ago, by the brilliant theory of Hutton and the fruitful generalization of Smith, the study of the earth received in our country the impetus which has given birth to the modern science of geology.

To review the marvellous progress which this science has made during the first century of its existence would require not one but many hours for adequate treatment. The march of discovery has advanced along a multitude of different paths, and the domains of Nature which have been included within the growing territories of human knowledge have been many and ample. Nevertheless, there are certain departments of investigation to which we may profitably restrict our attention on the present occasion, and wherein we may see how the leading principles that were proclaimed in this city a hundred years ago have germinated and borne fruit all over the world.

From the earliest times the natural features of the earth's surface have arrested the attention of mankind. The rugged mountain, the cleft ravine, the scarped cliff, the solitary boulder, have stimulated curiosity and prompted many a speculation as to their origin. The shells embedded by millions in the solid rocks of hills far removed from the sea have still further pressed home these "obstinate questionings." But for many long centuries the advance of inquiry into such matters was arrested by the paramount influence of orthodox theology. It was not merely that the Church opposed itself to the simple and obvious interpretation of these natural phenomena. So implicit had faith become in the accepted views of the earth's age and of the history of creation, that even laymen of intelligence and learning set themselves unbidden and in perfect good faith to explain away the difficulties which Nature so persistently raised up, and to reconcile her teachings with those of the theologians. In the various theories thus originating, the amount of knowledge of natural law usually stood in inverse ratio to the share played in them by an uncontrolled imagination. The speculations, for example, of Burnet, Whiston, Whitehurst, and others in this country, cannot be read now without a smile. In no sense were they scientific researches; they can only be looked upon as exercitations of learned ignorance. Springing mainly out of a laudable desire to promote what was believed to be the cause of true religion, they helped to retard inquiry, and exercised in that respect a baneful influence on intellectual progress.

It is the special glory of the Edinburgh school of geology to have cast aside all this fanciful trifling. Hutton boldly proclaimed that it was no part of his philosophy to account for the beginning of things. His concern lay only with the evidence furnished by the earth itself as to its origin. With the intuition of true genius he early perceived that the only solid basis from which to explore what has taken place in byegone time is a knowledge of what is taking place to-day. He thus founded his system upon a careful study of the processes whereby geological changes are now brought about. He felt assured that Nature must be consistent and uniform in her working, and that only in proportion as her operations at the present time are watched and understood will the ancient history of the earth become intelligible. Thus, in his hands, the investigation of the Present became the key to the interpretation of the Past. The establishment of this great truth was the first step towards the inauguration of a true science of the earth. The doctrine of the uniformity of causation in Nature became the fruitful principle on which the structure of modern geology could be built up.

Fresh life was now breathed into the study of the earth. A new spirit seemed to animate the advance along every pathway of inquiry. Facts that had long been familiar came to possess a wider and deeper meaning when their connection with each other was recognized as parts of one great harmonious system of continuous change. In no department of Nature, for example, was this broader vision more remarkably displayed than in that wherein the circulation of water between land and sea plays the most conspicuous part. From the earliest times men had watched the coming of clouds, the fall of rain, the flow of rivers, and had recognized that on this nicely adjusted machinery the beauty and fertility of the land depend. But they now learnt that this beauty and fertility involve a continual decay of the terrestrial surface; that the soil is a measure of this decay, and would cease to afford us maintenance were it not continually removed and renewed; that through the ceaseless transport of soil by rivers to the sea the face of the land is slowly lowered in level and carved into mountain and valley, and that the materials thus borne outwards to the floor of the ocean are not lost, but accumulate there to form rocks, which in the end will be upraised into new lands. Decay and renovation, in well-balanced proportions, were thus shown to be the system on which the existence of the earth as a habitable globe had been established. It was impossible to conceive that the economy of the planet could be maintained on any other basis. Without the circulation of water the life of plants and animals would be impossible, and with that circulation the decay of the surface of the land and the renovation of its disintegrated materials are necessarily involved.

As it is now so must it have been in past time. Hutton and Playfair pointed to the stratified rocks of the earth's crust as demonstrations that the same processes which are at work to-day have been in operation from a remote antiquity. By thus placing their theory on a basis of actual observation, and providing in the study of existing operations a guide to the interpretation of those in past times, they rescued the investigation of the history of the earth from the speculations of theologians and cosmologists, and established a place for it among the recognized inductive sciences. To the guiding influence of their philosophical system the prodigious strides made by modern geology are in large measure to be attributed. And here in their own city, after the lapse of a hundred years, let us offer to their memory the grateful homage of all who have profited by their labours.

But while we recognize with admiration the far-reaching influence of the doctrine of uniformity of causation in the investigation of the history of the earth, we must upon reflection admit that the doctrine has been pushed to an extreme perhaps not contemplated by its original founders. To take the existing conditions of Nature as a platform of actual knowledge from which to start in an inquiry into former conditions was logical and prudent. Obviously, however, human experience, in the few centuries during which attention has been turned to such subjects, has been too brief to warrant any dogmatic assumption that the various natural processes must have been carried on in the past with the same energy and at the same rate as they are carried on now. Variations in energy might have been legitimately conceded as possible, though not to be allowed without reasonable proof in their favour. It was right to refuse to admit the operation of speculative causes of change when the phenomena were capable of natural and adequate explanation by reference to causes that can be watched and investigated. But it was an error to take for granted that no other kind of process or influence, nor any variation in the rate of activity save those of which man has had actual cognizance, has played a part in the terrestrial economy. The uniformitarian writers laid themselves open to the charge of maintaining a kind of perpetual motion in the machinery of Nature. They could find in the records of the earth's history no evidence of a beginning, no prospect of an end. They saw that many successive renovations and destructions had been effected on the earth's surface, and that this long line of vicissitudes formed a series of which the earliest were lost in antiquity, while the latest were still in progress towards an apparently illimitable future.

The discoveries of William Smith, had they been adequately understood, would have been seen to offer a corrective to this rigidly uniformitarian conception, for they revealed that the crust of the earth contains the long record of an unmistakable order of progression in organic types. They proved that plants and animals have varied widely in successive periods of the earth's history, the present condition of organic life being only the latest phase of a long preceding series, each stage of which recedes further from the existing aspect of things as we trace it backward into the past. And though no relic had yet been found, or indeed was ever likely to be found, of the first living things that appeared upon the earth's surface, the manifest simplification of types in the older formations pointed irresistibly to some beginning from which the long procession had taken its start. If then it could thus be demonstrated that there had been upon the globe an orderly march of living forms from the lowliest grades in early times to man himself to day, and thus that in one department of her domain, extending through the greater portion of the records of the earth's history, Nature had not been uniform but had followed a vast and noble plan of evolution, surely it might have been expected that those who discovered and made known this plan would seek to ascertain whether some analogous physical progression from a definite beginning might not be discernible in the framework of the globe itself.

But the early masters of the science laboured under two great disadvantages. In the first place, they found the oldest records of the earth's history so broken up and effaced as to be no longer legible. And in the second place, they lived under the spell of that strong reaction against speculation which followed the bitter controversy between the Neptunists and Plutonists in the earlier decades of the century. They considered themselves bound to search for facts, not to build up theories; and as in the crust of the earth they could find no facts which threw any light upon the primeval constitution and subsequent development of our planet, they shut their ears to any theoretical interpretations that might be offered from other departments of science. It was enough for them to maintain, as Hutton had done, that in the visible structure of the earth itself no trace can be found of the beginning of things, and that the oldest terrestrial records reveal no physical conditions essentially different from those in which we still live. They doubtless listened with interest to the speculations of Kant, Laplace, and Herschel, on the probable evolution of nebulæ, suns, and planets, but it was with the languid interest attaching to ideas that lay outside of their own domain of research. They recognized no practical connection between such speculations and the data furnished by the earth itself as to its own history and progress.

This curious lethargy with respect to theory on the part of men who were popularly regarded as among the most speculative followers of science would probably not have been speedily dispelled by any discovery made within their own field of observation. Even now, after many years of the most diligent research, the first chapters of our planet's history remain undiscovered or undecipherable. On the great terrestrial palimpsest the earliest inscriptions seem to have been hopelessly effaced by those of later ages. But the question of the primeval condition and subsequent history of the planet might be considered from the side of astronomy and physics. And it was by investigations of this nature that the geological torpor was eventually dissipated. To our illustrious former President, Lord Kelvin, who occupied this chair when the Association last met in Edinburgh, is mainly due the rousing of attention to this subject. By the most convincing arguments he showed how impossible it was to believe in the extreme doctrine of uniformitarianism. And though, owing to uncertainty in regard to some of the data, wide limits of time were postulated by him, he insisted that within these limits the whole evolution of the earth and its inhabitants must have been comprised. While, therefore, the geological doctrine that the present order of Nature must be our guide to the interpretation of the past remained as true and fruitful as ever, it had now to be widened by the reception of evidence furnished by a study of the earth as a planetary body. The secular loss of heat, which demonstrably takes place both from the earth and the sun, made it quite certain that the present could not have been the original condition of the system. This diminution of temperature with all its consequences is not a mere matter of speculation, but a physical fact of the present time as much as any of the familiar physical agencies that affect the surface of the globe. It points with unmistakable directness to that beginning of things of which Hutton and his followers could find no sign.

Another modification or enlargement of the uniformitarian doctrine was brought about by continued investigation of the terrestrial crust and consequent increase of knowledge respecting the history of the earth. Though Hutton and Playfair believed in periodical catastrophes, and indeed required these to recur in order to renew and preserve the habitable condition of our planet, their successors gradually came to view with repugnance any appeal to abnormal, and especially to violent manifestations of terrestrial vigour, and even persuaded themselves that such slow and comparatively feeble action as had been witnessed by man could alone be recognized in the evidence from which geological history must be compiled. Well do I remember in my own boyhood what a cardinal article of faith this prepossession had become. We were taught by our great and honoured master, Lyell, to believe implicitly in gentle and uniform operations, extended over indefinite periods of time, though possibly some, with the zeal of partisans, carried this belief to an extreme which Lyell himself did not approve. The most stupendous marks of terrestrial disturbance, such as the structure of great mountain chains, were deemed to be more satisfactorily accounted for by slow movements prolonged through indefinite ages than by any sudden convulsion.

What the more extreme members of the uniformitarian school failed to perceive was the absence of all evidence that terrestrial catastrophes even on a colossal scale might not be a part of the present economy of this globe. Such occurrences might never seriously affect the whole earth at one time, and might return at such wide intervals that no example of them has yet been chronicled by man. But that they have occurred again and again, and even within comparatively recent geological times, hardly admits of serious doubt. How far at different epochs and in various degrees they may have included the operation of cosmical influences lying wholly outside the planet, and how far they have resulted from movements within the body of the planet itself, must remain for further inquiry. Yet the admission that they have played a part in geological history may be freely made without impairing the real value of the Huttonian doctrine, that in the interpretation of this history our main must be a knowledge of the existing processes of terrestrial change.

As the most recent and best known of these great transformations, the Ice Age stands out conspicuously before us. If any one sixty years ago had ventured to affirm that at no very distant date the snows and glaciers of the Arctic regions stretched southwards into France, he would have been treated as a mere visionary theorist. Many of the facts to which he would have appealed in support of his statement were already well known, but they had received various other interpretations. By some observers, notably by Hutton's friend, Sir James Hall, they were believed to be due to violent debacles of water that swept over the face of the land. By others they were attributed to the strong tides and currents of the sea when the land stood at a lower level. The uniformitarian school of Lyell had no difficulty in elevating or depressing land to any required extent. Indeed, when we consider how averse these philosophers were to admit any kind or degree of natural operation other than those of which there was some human experience, we may well wonder at the boldness with which, on sometimes the slenderest evidence, they made land and sea change places, on the one hand submerging mountain-ranges, and on the other placing great barriers of land where a deep ocean rolls. They took such liberties with geography because only well-established processes of change were invoked in the operations. Knowing that during the passage of an earthquake a territory bordering the sea may be upraised or sunk a few feet, they drew the sweeping inference that any amount of upheaval or depression of any part of the earth's surface might be claimed in explanation of geological problems. The progress of inquiry, while it has somewhat curtailed this geographical license, has now made known in great detail the strange story of the Ice Age.

There cannot be any doubt that after man had become a denizen of the earth, a great physical change came over the northern hemisphere. The climate, which had previously been so mild that evergreen trees flourished within ten or twelve degrees of the north pole, now became so severe that vast sheets of snow and ice covered the north of Europe and crept southward beyond the south coast of Ireland, almost as far as the southern shores of England, and across the Baltic into France and Germany. This Arctic transformation was not an episode that lasted merely a few seasons, and left the land to resume thereafter its ancient aspect. With various successive fluctuations it must have endured for many thousands of years. When it began to disappear it probably faded away as slowly and imperceptibly as it had advanced, and when it finally vanished it left Europe and North America profoundly changed in the character alike of their scenery and of their inhabitants. The rugged rocky contours of earlier times were ground smooth and polished by the march of the ice across them, while the lower grounds were buried under wide and thick sheets of clay, gravel, and sand, left behind by the melting ice. The varied and abundant flora which had spread so far within the Arctic circle was driven away into more southern and less ungenial climes. But most memorable of all was the extirpation of the prominent large animals which, before the advent of the ice, had roamed over Europe. The lions, hyænas, wild horses, hippopotami, and other creatures either became entirely extinct or were driven into the Mediterranean basin and into Africa. In their place came northern forms—the reindeer, glutton, musk ox, woolly rhinoceros, and mammoth.

Such a marvellous transformation in climate, in scenery, in vegetation and in inhabitants, within what was after all but a brief portion of geological time, though it may have involved no sudden or violent convulsion, is surely entitled to rank as a catastrophe in the history of the globe. It was probably brought about mainly if not entirely by the operation of forces external to the earth. No similar calamity having befallen the continents within the time during which man has been recording his experience, the Ice Age might be cited as a contradiction to the doctrine of uniformity, and yet it manifestly arrived as part of the established order of Nature. Whether or not we grant that other ice ages preceded the last great one, we must admit that the conditions under which it arose, so far as we know them, might conceivably have occurred before and may occur again. The various agencies called into play by the extensive refrigeration of the northern hemisphere were not different from those with which we are familiar. Snow fell and glaciers crept as they do to-day. Ice scored and polished rocks exactly as it still does among the Alps and in Norway. There was nothing abnormal in the phenomena save the scale on which they were manifested. And thus, taking a broad view of the whole subject, we recognize the catastrophe, while at the same time we see in its progress the operation of those same natural processes which we know to be integral parts of the machinery whereby the surface of the earth is continually transformed.

Among the debts which science owes to the Huttonian school, not the least memorable is the promulgation of the first well-founded conceptions of the high antiquity of the globe. Some six thousand years had previously been believed to comprise the whole life of the planet, and indeed of the entire universe. When the curtain was then first raised that had veiled the history of the earth, and men, looking beyond the brief span within which they had supposed that history to have been transacted, behold the records of a long vista of ages stretching far away into a dim illimitable past, the prospect vividly impressed their imagination. Astronomy had made known the immeasurable fields of space; the new science of geology seemed now to reveal boundless distances of time. The more the terrestrial chronicles were studied the farther could the eye range into an antiquity so vast as to defy all attempts to measure or define it. The progress of research continually furnished additional evidence of the enormous duration of the ages that preceded the coming of man, while, as knowledge increased, periods that were thought to have followed each other consecutively were found to have been separated by prolonged intervals of time. Thus the idea arose and gained universal acceptance that, just as no boundary could be set to the astronomer in his free range through space, so the whole of bygone eternity lay open to the requirements of the geologist. Playfair, re-echoing and expanding Hutton's language, had declared that neither among the records of the earth nor in the planetary motions can any trace be discovered of the beginning or of the end of the present order of things; that no symptom of infancy or of old age has been allowed to appear on the face of Nature, nor any sign by which either the past or the future duration of the universe can be estimated; and that although the Creator may put an end, as He no doubt gave a beginning, to the present system, such a catastrophe will not be brought about by any of the laws now existing, and is not indicated by anything which we perceive. This doctrine was naturally espoused with warmth by the extreme uniformitarian school, which required an unlimited duration of time for the accomplishment of such slow and quiet cycles of change as they conceived to be alone recognizable in the record of the earth's past history.

It was Lord Kelvin who, in the writings to which I have already referred, first called attention to the fundamentally erroneous nature of these conceptions. He pointed out that from the high internal temperature of our globe, increasing inwards as it does, and from the rate of loss of its heat, a limit may be fixed to the planet's antiquity. He showed that so far from there being no sign of a beginning, and no prospect of an end to the present economy, every lineament of the solar system bears witness to a gradual dissipation of energy from some definite starting-point. No very precise data were then, or indeed are now, available for computing the interval which has elapsed since that remote commencement, but he estimated that the surface of the globe could not have consolidated less than twenty millions of years ago, for the rate of increase of temperature inwards would in that case have been higher than it actually is; nor more than 400 millions of years ago, for then there would have been no sensible increase at all. He was inclined, when first dealing with the subject, to believe that from a review of all the evidence then available, some such period as 100 millions of years would embrace the whole geological history of the globe.

It is not a pleasant experience to discover that a fortune which one has unconcernedly believed to be ample has somehow taken to itself wings and disappeared. When the geologist was suddenly awakened by the energetic warning of the physicist, who assured him that he had enormously overdrawn his account with past time, it was but natural under the circumstances that he should think the accountant to be mistaken, who thus returned to him dishonoured the large drafts he had made on eternity. He saw how wide were the limits of time deducible from physical considerations, how vague the data from which they had been calculated. And though he could not help admitting that a limit must be fixed beyond which his chronology could not be extended, he consoled himself with the reflection that after all a hundred millions of years was a tolerably ample period of time, and might possibly have been quite sufficient for the transaction of all the prolonged sequence of events recorded in the crust of the earth. He was therefore disposed to acquiesce in the limitation thus imposed upon geological history.

But physical inquiry continued to be pushed forward with regard to the early history and the antiquity of the earth. Further consideration of the influence of tidal friction in retarding the earth's rotation, and of the sun's rate of cooling, led to sweeping reductions of the time allowable for the evolution of the planet. The geologist found himself in the plight of Lear when his bodyguard of one hundred knights was cut down. "What need you five-and-twenty, ten or five?" demands the inexorable physicist, as he remorselessly strikes slice after slice from his allowance of geological time. Lord Kelvin is willing, I believe, to grant us some twenty millions of years, but Prof. Tait would have us content with less than ten millions.

In scientific as in other mundane questions there may often be two sides, and the truth may ultimately be found not to lie wholly with either. I frankly confess that the demands of the early geologists for an unlimited series of ages were extravagant, and, even for their own purposes, unnecessary, and that the physicist did good service in reducing them. It may also be freely admitted that the latest conclusions from physical considerations of the extent of geological time require that the interpretation given to the record of the rocks should be rigorously revised, with the view of ascertaining how far that interpretation may be capable of modification or amendment. But we must also remember that the geological record constitutes a voluminous body of evidence regarding the earth's history which cannot be ignored, and must be explained in accordance with ascertained natural laws. If the conclusions derived from the most careful study of this record cannot be reconciled with those drawn from physical considerations, it is surely not too much to ask that the latter should be also revised. It has been well said that the mathematical mill is an admirable piece of machinery, but that the value of what it yields depends upon the quality of what is put into it. That there must be some flaw in the physical argument I can, for my own part, hardly doubt, though I do not pretend to be able to say where it is to be found. Some assumption, it seems to me, has been made, or some consideration has been left out of sight, which will eventually be seen to vitiate the conclusions, and which when duly taken into account will allow time enough for any reasonable interpretation of the geological record.

In problems of this nature, where geological data capable of numerical statement are so needful, it is hardly possible to obtain trustworthy computations of time. We can only measure the rate of changes in progress now, and infer from these changes the length of time required for the completion of results achieved by the same processes in the past. There is fortunately one great cycle of movement which admits of careful investigation, and which has been made to furnish valuable materials for estimates of this kind. The universal degradation of the land, so notable a characteristic of the earth's surface, has been regarded as an extremely slow process. Though it goes on without ceasing, yet from century to century it seems to leave hardly any perceptible trace on the landscapes of a country. Mountains and plains, hills and valleys, appear to wear the same familiar aspect which is indicated in the oldest pages of history. This obvious slowness in one of the most important departments of geological activity, doubtless contributed in large measure to form and foster a vague belief in the vastness of the antiquity required for the evolution of the earth.

But, as geologists eventually came to perceive, the rate of degradation of the land is capable of actual measurement. The amount of material worn away from the surface of any drainage-basin and carried in the form of mud, sand, or gravel, by the main river into the sea, represents the extent to which that surface has been lowered by waste in any given period of time. But denudation and deposition must be equivalent to each other. As much material must be laid down in sedimentary accumulations as has been mechanically removed, so that in measuring the annual bulk of sediment borne into the sea by a river, we obtain a clue not only to the rate of denudation of the land, but also to the rate at which the deposition of new sedimentary formations takes place.

As might be expected, the activities involved in the lowering of the surface of the land are not everywhere equally energetic. They are naturally more vigorous where the rainfall is heavy, where the daily range of temperature is large, and where frosts are severe. Hence they are obviously much more effective in mountainous regions than on plains; and their results must constantly vary, not only in different basins of drainage, but even, and sometimes widely, within the same basin. Actual measurement of the proportion of sediment in river water shows that while in some cases the lowering of the surface of the land may be as much as $\frac{1}{730}$ of a foot in a year, in others it falls as low as $\frac{1}{6800}$. In other words, the rate of deposition of new sedimentary formations, over an area of sea-floor equivalent to that which has yielded the sediment, may vary from one foot in 730 years to one foot in 6,800 years.

If now we take these results and apply them as measures of the length of time required for the deposition of the various sedimentary masses that form the outer part of the earth's crust, we obtain some indication of the duration of geological history. On a reasonable computation these stratified masses, where most fully developed, attain a united thickness of not less than 100,000 feet. If they were all laid down at the most rapid recorded rate of denudation, they would require a period of seventy-three millions of years for their completion. If they were laid down at the slowest rate they would demand a period of not less than 680 millions.

But it may be argued that all kinds of terrestrial energy are growing feeble, that the most active denudation now in progress is much less vigorous than that of bygone ages, and hence that the stratified part of the earth's crust may have been put together in a much briefer space of time than modern events might lead us to suppose. Such arguments are easily adduced and look sufficiently specious, but no confirmation of them can be gathered from the rocks. On the contrary, no one can thoughtfully study the various systems of stratified formations without being impressed by the fulness of their evidence that, on the whole, the accumulation of sediment has been extremely slow. Again and again we encounter groups of strata composed of thin paper-like laminæ of the finest silt, which evidently settled down quietly and at intervals on the sea bottom. We find successive layers covered with ripple-marks and sun-cracks, and we recognize in them memorials of ancient shores where sand and mud tranquilly gathered as they do in sheltered estuaries at the present day. We can see no proof whatever, nor even any evidence which suggests, that on the whole the rate of waste and sedimentation was more rapid during Mesozoic and Palæozoic time than it is to-day. Had there been any marked difference in this rate from ancient to modern times, it would be incredible that no clear proof of it should have been recorded in the crust of the earth.

But in actual fact the testimony in favour of the slow accumulation and high antiquity of the geological record is much stronger than might be inferred from the mere thickness of the stratified formations. These sedimentary deposits have not been laid down in one unbroken sequence, but have had their continuity interrupted again and again by upheaval and depression. So fragmentary are they in some regions, that we can easily demonstrate the length of time represented there by still existing sedimentary strata to be vastly less than the time indicated by the gaps in the series.

There is yet a further and impressive body of evidence furnished by the successive races of plants and animals which have lived upon the earth and have left their remains sealed up within its rocky crust. No one now believes in the exploded doctrine that successive creations and universal destructions of organic life are chronicled in the stratified rocks. It is everywhere admitted that, from the remotest times up to the present day, there has been an onward march of development, type succeeding type in one long continuous progression. As to the rate of this evolution precise data are wanting. There is, however, the important negative argument furnished by the absence of evidence of recognizable specific variations of organic forms since man began to observe and record. We know that within human experience a few species have become extinct, but there is no conclusive proof that a single new species has come into existence, nor are appreciable variations readily apparent in forms that live in a wild state. The seeds and plants found with Egyptian mummies, and the flowers and fruits depicted on Egyptian tombs, are easily identified with the vegetation of modern Egypt. The embalmed bodies of animals found in that country show no sensible divergence from the structure or proportions of the same animals at the present day. The human races of Northern Africa and Western Asia were already as distinct when portrayed by the ancient Egyptian artists as they are now, and they do not seem to have undergone any perceptible change since then. Thus a lapse of four or five thousand years has not been accompanied by any recognizable variation in such forms of plant and animal life as can be tendered in evidence. Absence of sensible change in these instances is, of course, no proof that considerable alteration may not have been accomplished in other forms more exposed to vicissitudes of climate and other external influences. But it furnishes at least a presumption in favour of the extremely tardy progress of organic variation.

If, however, we extend our vision beyond the narrow range of human history, and look at the remains of the plants and animals preserved in those younger formations which, though recent when regarded as parts of the whole geological record, must be many thousands of years older than the very oldest of human monuments, we encounter the most impressive proofs of the persistence of specific forms. Shells which lived in our seas before the coming of the Ice Age present the very same peculiarities of form, structure, and ornament which their descendants still possess. The lapse of so enormous an interval of time has not sufficed seriously to modify them. So too with the plants and the higher animals which still survive. Some forms have become extinct, but few or none which remain display any transitional gradations into new species. We must admit that such transitions have occurred, that indeed they have been in progress ever since organized existence began upon our planet, and are doubtless taking place now. But we cannot detect them on the way, and we feel constrained to believe that their march must be excessively slow.

There is no reason to think that the rate of organic evolution has ever seriously varied; at least no proof has been adduced of such variation. Taken in connection with the testimony of the sedimentary rocks, the inferences deducible from fossils entirely bear out the opinion that the building up of the stratified crust of the earth has been extremely gradual. If the many thousands of years which have elapsed since the Ice Age have produced no appreciable modification of surviving plants and animals, how vast a period must have been required for that marvellous scheme of organic development which is chronicled in the rocks!

After careful reflection on the subject, I affirm that the geological record furnishes a mass of evidence which no arguments drawn from other departments of Nature can explain away, and which, it seems to me, cannot be satisfactorily interpreted save with an allowance of time much beyond the narrow limits which recent physical speculation would concede.

I have reserved for final consideration a branch of the history of the earth which, while it has become, within the lifetime of the present generation, one of the most interesting and fascinating departments of geological inquiry, owed its first impulse to the far-seeing intellects of Hutton and Playfair. With the penetration of genius these illustrious teachers perceived that if the broad masses of land and the great chains of mountains owe their origin to stupendous movements which from time to time have convulsed the earth, their details of contour must be mainly due to the eroding power of running water. They recognized that as the surface of the land is continually worn down, it is essentially by a process of sculpture that the physiognomy of every country has been developed, valleys being hollowed out and hills left standing, and that these inequalities in topographical detail are only varying and local accidents in the progress of the one great process of the degradation of the land.

From the broad and guiding outlines of theory thus sketched we have now advanced amid ever-widening multiplicity of detail into a fuller and nobler conception of the origin of scenery. The law of evolution is written as legibly on the landscapes of the earth as on any other page of the Book of Nature. Not only do we recognize that the existing topography of the continents, instead of being primeval in origin, has gradually been developed after many precedent mutations, but we are enabled to trace these earlier revolutions in the structure of every hill and glen. Each mountain-chain is thus found to be a memorial of many successive stages in geographical evolution. Within certain limits, land and sea have changed places again and again. Volcanoes have broken out and have become extinct in many countries long before the advent of man. Whole tribes of plants and animals have meanwhile come and gone, and in leaving their remains behind them as monuments at once of the slow development of organic types, and of the prolonged vicissitudes of the terrestrial surface, have furnished materials for a chronological arrangement of the earth's topographical features. Nor is it only from the organisms of former epochs that broad generalizations may be drawn regarding revolutions in geography. The living plants and animals of to-day have been discovered to be eloquent of ancient geographical features that have long since vanished. In their distribution they tell us that climates have changed, that islands have been disjoined from continents, that oceans once united have been divided from each other, or once separate have now been joined; that some tracts of land have disappeared, while others for prolonged periods of time have remained in isolation. The present and the past are thus linked together not merely by dead matter, but by the world of living things, into one vast system of continuous progression.

In this marvellous increase of knowledge regarding the transformations of the earth's surface, one of the most impressive features, to my mind, is the power now given to us of perceiving the many striking contrasts between the present and former aspects of topography and scenery. We seem to be endowed with a new sense. What is seen by the bodily eye—mountain, valley, or plain—serves but as a veil, beyond which, as we raise it, visions of long-lost lands and seas rise before us in a far-retreating vista. Pictures of the most diverse and opposite character are beheld, as it were, through each other, their lineaments subtly interwoven and even their most vivid contrasts subdued idto one blended harmony. Like the poet, "we see, but not by sight alone;" and the "ray of fancy" which, as a sunbeam, lightened up his landscape, is for us broadened and brightened by that play of the imagination which science can so vividly excite and prolong.

Admirable illustrations of this modern interpretation of scenery are supplied by the district wherein we are now assembled. On every side of us rise the most convincing proofs of the reality and potency of that ceaseless sculpture by which the elements of landscape have been carved into their present shapes. Turn where we may, our eyes rest on hills that project above the lowland, not because they have been upheaved into these positions, but because their stubborn materials have enabled them better to withstand the degradation which has worn down the softer strata into the plains around them. Inch by inch the surface of the land has been lowered, and each hard rock successively laid bare has communicated its own characteristics of form and colour to the scenery.

If, standing on the Castle Rock, the central and oldest site in Edinburgh, we allow the bodily eye to wander over the fair landscape, and the mental vision to range through the long vista of earlier landscapes which science here reveals to us, what a strange series of pictures passes before our gaze! The busy streets of to-day seem to fade away into the mingled copsewood and forest of prehistoric time. Lakes that have long since vanished gleam through the woodlands, and a rude canoe pushing from the shore startles the red deer that had come to drink. While we look, the picture changes to a polar scene, with bushes of stunted Arctic willow and birch, among which herds of reindeer browse and the huge mammoth makes his home. Thick sheets of snow are draped all over the hills around, and far to the north-west the distant gleam of glaciers and snow-fields marks the line of the Highland mountains. As we muse on this strange contrast to the living world of to-day the scene appears to grow more Arctic in aspect, until every hill is buried under one vast sheet of ice, 2,000 feet or more in thickness, which fills up the whole midland valley of Scotland and creeps slowly eastward into the basin of the North Sea. Here the curtain drops upon our moving pageant, for in the geological record of this part of the country an enormous gap occurs before the coming of the Ice Age.

When once more the spectacle resumes its movement the scene is found to have utterly changed. The familiar hills and valleys of the Lothians have disappeared. Dense jungles of a strange vegetation—tall reeds, club-mosses, and tree-ferns—spread over the steaming swamps that stretch for leagues in all directions. Broad lagoons and open seas are dotted with little volcanic cones which throw out their streams of lava and showers of ashes. Beyond these, in dimmer outline and older in date, we descry a wide lake or inland sea, covering the whole midland valley and marked with long lines of active volcanoes, some of them several thousand feet in height. And still further and fainter over the same region, we may catch a glimpse of that still earlier expanse of sea which in Silurian times overspread most of Britain. But beyond this scene our vision fails. We have reached the limit across which no geological evidence exists to lead the imagination into the primeval darkness beyond.

Such in briefest outline is the succession of mental pictures which modern science enables us to frame out of the landscapes around Edinburgh. They may be taken as illustrations of what may be drawn, and sometimes with even greater fulness and vividness, from any district in these islands. But I cite them especially because of their local interest in connection with the present meeting of the Association, and because the rocks that yield them gave inspiration to those great masters whose claims on our recollection, not least for their explanation of the origin of scenery, I have tried to recount this evening. But I am further impelled to dwell on these scenes from an overmastering personal feeling to which I trust I may be permitted to give expression. It was these green hills and grey crags that gave me in boyhood the impulse that has furnished the work and joy of my life. To them, amid changes of scene and surroundings, my heart ever fondly turns, and here I desire gratefully to acknowledge that it is to their influence that I am indebted for any claim I may possess to stand in the proud position in which your choice has placed me.

SECTION A.

MATHEMATICS AND PHYSICS.

OPENING ADDRESS BY PROF. ARTHUR SCHUSTER, PH.D., F.R.S., F.R.A.S., PRESIDENT OF THE SECTION.

IN opening the proceedings of our Annual Meeting the temptation is great to look back on the year which has passed and to select for special consideration such work published during its course as may seem to be of the greatest importance. I fear, however, that a year is too short a time to allow us to form a fair estimate of the value of a scientific investigation. The mushroom, which shoots up quickly, only to disappear again, impresses us more than the slow-growing seedling which will live to be a tree, and it is difficult to recognize the scientific fungus in its early stage. But, although I do not feel competent to give you a review of the progress made in our subject during the last twelve months, there is one event to which some allusion should be made. It has been the sad duty of many of my predecessors to announce the death of successful workers in the field of science, but I believe I am unique in having the pleasure of recording the birth of a scientific man. At the beginning of this year there came into the world a being so brilliant that he could, without preparation, take up the work of the most eminent man amongst us. Believers in the transmigration of souls have speculated on the fact that Galileo's death and Newton's birth fell within a year of each other; but no event has ever happened so striking as that which took place on the 1st of January, when the mantle of Sir William Thomson fell on the infant Lord Kelvin. Those who have attended these meetings will feel with me that the honour done to our foremost representative, an honour which has been a source of pride and satisfaction to every student of science, could not altogether remain unnoticed in the section which owes him so much.

We are chiefly concerned here with the increase of scientific knowledge, and we derive pleasure in contrasting the minor state of ignorance of our own time with that which prevailed a hundred years ago. But when we contrast at the same time the refined opportunities of a modern research laboratory with the crude conditions under which the experimentalist had to work at the beginning of the century, we may fairly ask ourselves whether it is possible by means of any systematic course of study or by means of any organisation to accelerate our progress into the dark continent of science. A number of serious considerations arise in connection with this subject, and though I am not going to weary you by attempting an exhaustive discussion, I should like to draw your attention to a few matters which seem to me to be well worthy of the consideration of this Association. Changes are constantly made and proposed in our existing institutions, or new ones are suggested which are to serve the purpose of a more rapid accumulation of knowledge. I need only allude to the alterations in the curriculum of the science schools in our old Universities, made partly for the purpose of fitting their graduates for the conduct of original research, or to the national laboratory proposed by my predecessor in this chair for carrying out a certain kind of scientific investigation, which at present is left undone, or is done by private enterprise. Even our own Association has not escaped the evil eye of the reformer, and, like other institutions, it may be capable of improvement. But in choosing the direction in which a change may best be made, I think we may learn something from the way in which Nature improves its organisms. We are taught by biologists that natural selection acts by developing those qualities which enable each species best to survive the struggle for existence; useless organs die off or become rudimentary. Nature teaches us, therefore, how a beautiful complex of beings, mutually dependent on each other, is formed by improving those parts which are best and most useful, and letting the rest take care of itself. But in many of the changes which have been made or are proposed the process of reform is very different. The weakest points are selected, our attention is drawn to some failure or something in which we are excelled by other nations, and attempts are made to cure what perhaps had better be left to become rudimentary. The proceeding is not objectionable as long as the nourishment which is applied to develop the weaker organs is not taken from those parts which we should specially take care to preserve. To apply these reflections to the questions with which we are specially concerned, I should like to see it more generally recognized that although there is no struggle for existence between different nations, yet each nation, owing to a number of circumstances, possesses its own peculiarities, which render it better fitted than its neighbours to do some particular part of the work on which the progress of science depends. No country, for instance, has rivalled France in the domain of accurate measurement, with which the names of Regnault and Amagat are associated, and the International Bureau of Weights and Measures has its fitting home in Paris.[1] The best work of the German Universities seems to me to consist in the following up of some theory to its logical conclusions and submitting it to the test of experiment. I doubt whether the efforts to transplant the research work of German Universities into this country will prove successful. Does it not seem well to let each country take that share of work for which the natural growth of its character and its educational establishment best adapt it? Is it wise to remedy some weak point, to fill up undoubted gaps, if the soil that fills the gaps has to be taken from the hills and elevations which rise above the surrounding level?

As far as the work of this section is concerned the strongest domain of this country has been that of mathematical physics. But it is not to this that I wish specially to refer. Look at the work done in Great Britain during the last two centuries; the work not only in physics, but in astronomy, chemistry, biology. Is it not true that the one distinctive feature which separates this from all other countries in the world is the prominent part played by the scientific amateur, and is it not also true that our modern system of education tends to destroy the amateur?

By amateur I do not necessarily mean a man who has other occupations and only takes up science in his leisure hours, but rather one who has had no academical training, at any rate in that branch of knowledge which he finally selects for study. He has probably been brought up for some profession unconnected with science, and only begins his study when his mind is sufficiently developed to form an entirely unbiassed opinion. We may, perhaps, best define an amateur as one who learns his science as he wants it and when he wants it. I should call Faraday an amateur. He would have been impossible in another country; perhaps he would be impossible in the days of the Science and Art Department. Other names will occur to you, the most typical and eminent being that of Joule. It is not my purpose to discuss why distinguished amateurs have been so numerous in this country, but I am anxious to point out that we are in danger of losing one great and necessary factor in the origination of scientific ideas.

One of the distinctive features of an amateur is this, that he carries the weight of theories, often not the weight of knowledge, and, if I am right, there is a distinct advantage in having one section of scientific men beginning their work untrammelled by preconceived notions, which a systematic training in science is bound to instil. Whatever is taught in early age must necessarily be taught in a more or less dogmatic manner, and, in whatever way it is taught, experience shows that it is nearly always received in a dogmatic spirit. It seems important, therefore, to confine the early training to those subjects in which preconceived notions are considered an advantage. It is to me an uncongenial task to sound a note of warning to our old Universities, for the chief difficulties in which they are placed at present are due to the fact that they have given way too much to outside advice; but I cannot help expressing a strong conviction that their highly specialised entrance examinations are a curse to all sound school education, and will prove a still more fatal curse to what concerns us most nearly, the progress of scientific knowledge. If school examinations could be more general, if scientific theories could only be taught at an age when a man is able to form an independent judgment, there might be some hope of retaining that originality of ideas which has been a distinctive feature of this country, and enabled our amateurs to hold a prominent position in the history of science. At present a knowledge of scientific theories seems to me to kill all knowledge of scientific facts.

It is by no means true that a complete knowledge of everything that has a bearing on a particular subject is always necessary to success in an original investigation. In many cases such knowledge is essential, in others it is a hindrance. Different types of men incline to different types of research, and it is well to preserve the dual struggle. The engine which works out the great problems of nature may be likened to a thermodynamic machine. The amateur supplies the steam and the Universities supply the cold water; the former, boiling over often with ill-considered and fanciful ideas, does not like the icy douche, and the professional scientist does not like the latent heat of the condensing steam, but nevertheless the hotter the steam and the colder the water the better works the machine. Sometimes it happens that the boiler and cooler are both contained in the same brain, and each country can boast of a few such in a century, but most of us have to remain satisfied with forming only an incomplete part of the engine of research.

But while it is necessary to recognize the great work done by the unprofessional scientists, it seems not untimely to draw their attention to the damage done to themselves if they overstep their legitimate boundaries, and especially if they seek popular support for their theories, which have not received the approval of those who are competent to judge. An appeal from Alexander sober to Alexander drunk will not prove successful in the end.

The gradual disappearance of the amateur may be a necessary consequence of our increased educational facilities, and we must inquire whether any marked advantages are offered to us in exchange. There is one direction in which it would seem at first sight, at any rate, that a proper course of study could do much to facilitate the progress of research.

On another occasion I pointed out that two parties are necessary for every advance in science, the one that makes it and the one that believes in it. If the discoverer is born, and cannot be made, would it not be possible at any rate to train the judgment of our students so that they may form a sound opinion on the new theories and ideas which are presented to them? It is too early as yet to judge in how far our generation is better in this respect than the one that has gone before them, but on closer examination it does not seem to me to be obvious that any marked improvement is possible. Every new idea revolutionizing our opinions on some important question must necessarily take time before it takes a proper hold on the scientific world. Is it not true that anyone who can at once see the full importance of a new theory, and accept it in place of the one in which he has been brought up, must stand at a height almost equal to that of the originator? The more startling and fresh the new conception the fewer must be those who are ready to adopt it. But looking back at the history of science during the present century, is there much evidence that great discoveries have been seriously delayed by want of proper appreciation? We may hear of cases where important papers have been rejected by scientific societies, and occasionally a man of novel ideas may have been too much neglected by his contemporaries. I doubt whether such cases of apparent injustice can ever be avoided, and, simply looking back on the great changes involved in matters of primary importance, such as the undulatory theory of light, the conservation of energy, and the second law of thermodynamics, I cannot admit that there is much reason to be dissatisfied with the rate at which new theories have been received. Those who experience a temporary check, owing to the fact that public opinion is not ripe for their ideas, are often amply rewarded after the lapse of a few years. The disappointment which Joule may have felt during the time his views met with adverse criticisms from the official world of science was no doubt amply compensated by the pleasure with which he watched the subsequent progress of research in the new domain which his discoveries have opened out.

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[1] Much of the good work done by this Bureau remains unknown, owing to the miserly way in which their publications are circulated. No copies are supplied even to the University libraries. The explanation, of course, is "want of funds." In other words, England, France, and Germany, together with other nations, unite to do a certain kind of work, but cannot afford to distribute a few copies of the publication to the public for whose benefit the work is undertaken.

The point is not one of academic interest only, for the fear of repressing some important new discovery has a detrimental influence in another direction. The judgment of the scientific world seems to me to be tending too much towards leniency to apparently absurd theories, because there is a remote chance that they may contain some germ of real value. A new truth will not be found to suffer ultimately by adverse and even unreasonable criticism, while bad theories and bad reasoning, supported by the benevolent neutrality of those to whose judgment the scientific world looks for guidance, are harmful in many ways. They block the way to an independent advance and encourage hasty and ill-considered generalizations. The conclusions I should draw from the considerations I have placed before you are these: I believe that a reasonable censorship exercised by our scientific societies is good and necessary; that those whose fate it is to be called on to express an opinion on some work or theory should do so fearlessly according to their best judgment. Their opinion may be warped by prejudice, but I think it is better that they should incur the risk of being ultimately found to be wrong than that they should help in the propagation of bad reasoning. There is one matter, however, on which all opinions must agree. Worse than bad theory or logic is bad experimental work. Should we then not rigorously preserve any influence or incentive which encourages the beginner to avoid carelessness and to consider neither time nor trouble to secure accuracy? There is no doubt to my mind that the prospect of admission to the Royal Society has been most beneficial in this respect, and that the honourable ambition to see his paper published in the "Transactions" of that Society has preserved many a student from the premature publication of unfinished work.

One of the principal obstacles to the rapid diffusion of a new idea lies in the difficulty of finding suitable expression to convey its essential point to other minds. Words may have to be strained into a new sense, and scientific controversies constantly resolve themselves into differences about the meaning of words. On the other hand, a happy nomenclature has sometimes been more powerful than rigorous logic in allowing a new train of thought to be quickly and generally accepted.

A good example is furnished by the history of the science of energy. The principle of the conservation of energy has undoubtedly gained a more rapid and general acceptance than it would otherwise have had by the introduction of the word potential energy. A great theorem, which in itself seems to me to be an intricate one, has been simplified by calling something energy which, in the first place, is only a deficiency of kinetic energy. The only record I can find on the history of the expression is given in Tait's "Thermodynamics," wherein the term statical energy is ascribed to Lord Kelvin, and that of potential energy to Rankine. It would be of interest to have a more detailed account on the origin of an expression which has undoubtedly had a marked influence not only on the physics, but also on the metaphysics of our time. But while fully recognizing the very great advantage we have derived from this term "Potential Energy," we ought not, at the same time, to lose sight of the fact that it implies something more than can be said to be proved. It is easy to overstep the legitimate use of the word. Thus, when Professor Lodge[1] attempts to prove that action at a distance is not consistent with the doctrine of energy, he cannot, in my opinion, justify his position except by assuming that all energy is ultimately kinetic. That is a plausible but by no means a necessary theory. Efforts have been made to look on energy as on something which can be labelled and identified through its various transformations. Thus we may feel a certain bit of energy radiating from a coal-fire, and if our knowledge was complete, we ought to be able to fix the time at which that identical bit of energy left the sun and arrived on the surface of the earth, setting up a chemical action in the leaves of the plant from which the coal has been derived. If we push this view to a logical conclusion, it seems to me that we must finally arrive at an atomic conception of energy which some may consider an absurdity.

Let, for instance, a number of particles P_1, P_2, &c., in succession, strike another particle Q. How can we in the translatory energy of the latter identify the parts which P_1, P_2, &c., have contributed? According to Professor's Lodge's view, we should be able to do so, for if the particle Q in its turn gives up its energy to others, say R_1, R_2, R_3, &c., we ought to be able to say whether the energy of P_1 has ultimately gone into R_1 or into R_2, or is divided between them. It is only by imagining that all energy is made up of a finite number of bits, which pass from one body to another, that we can defend the idea of considering energy as capable of being "labelled."

In the expressions we adopt to prescribe physical phenomena we necessarily hover between two extremes. We either have to choose a word which implies more than we can prove, or we have to use vague and general terms which hide the essential point, instead of bringing it out. The history of electrical theories furnishes a good example. The terms positive and negative electricity committed us to something definite; we could reckon about quantities of electricity, and form some definite notion of electrical currents as a motion of the two kinds of electricity in opposite directions. Now we have changed all that; we speak of electric displacements, but safeguard ourselves by saying that a displacement only means a vector quantity, and not necessarily an actual displacement. We speak of lines and tubes of force not only as a help to realize more clearly certain analytical results, but as implying a physical theory to which, at the same time, we do not wish to commit ourselves. I do not find any fault with this, for it is a perfectly legitimate and necessary process to state the known connection between physical phenomena in some form which introduces the smallest number of assumptions. But the great question "What is electricity?" is not touched by these general considerations. The brilliant success with which Maxwell's investigations have been crowned is apt to make us overrate the progress made in the solution of that question. Maxwell and his followers have proved the important fact that optical and electrical actions are transmitted through the same medium. We may be said to have arrived in the subject of electricity at the stage in which optics was placed before Young and Fresnel hit on the idea of transverse vibrations, but there is no theory of electricity in the sense in which there is an elastic solid theory of light.

If the term electrical displacement was taken in its literal sense, it would mean that the electric current consists of the motion of the ether through the conductor. This is a plausible hypothesis, and one respecting which we may obtain experimental evidence. The experiments of Rayleigh and others have shown that the velocity of light in an electrolyte, through which an electric current is passing, is, within experimental limits, the same with and against the current. This result shows that if an electrical current means a motion of the ether the velocity of the medium cannot exceed ten metres a second for a current density of one ampère per square centimetre. This, then, is the upper limit for a possible velocity of the medium; can we find a lower limit? The answer to that question depends on the interpretation of a well-known experiment of Fizeau's, who found that the speed of light is increased if it travels through water which moves in the same direction as the light. If this experiment implies that the water carries the ether with it, and if a motion of the ether means an electric current, we should be led to the conclusion that a current of water should deflect a magnet in its neighbourhood. An experiment made to that effect would almost certainly give a negative result, and would give us a lower limit for the velocity of the medium corresponding to a given current. Such an experiment, together with that of Rayleigh, would probably dispose of the theory that an electric current is due to a translatory velocity of the medium. This would be an important step, and it would be worth while to arrive at a final settlement of the question.[1] The whole question of the relation between the motion of matter and motion of the medium is a vital one, and we shall probably not make any serious advances until experiment has found a new opening. But we must expect many negative results before some clue is discovered. Nor can we attach much importance to negative results unless they are made by some one in whose care and judgment we place full reliance. We should all the more, therefore, recognize the courage and perseverance of those who spend their valuable time in such investigations as Prof. Lodge has recently undertaken. That ultimately some relation will be found between moving matter and electrical action there is no reasonable doubt.

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[1] *Phil. Mag.* vol. xi. p. 36 (1881).

[1] Fizeau's results must either be due to the motion of matter through the medium or to the fact that moving matter carries the ether with it. If it is due to the former cause, and matter does *not* carry the ether with it, may we not consider that matter moving through the ether, that is a relative motion of matter and ether, must produce effects equal and opposite to those of ether moving through matter? In that case the reasoning in the text would, *mutatis mutandis*, hold good.

One of the most hopeful openings for new investigations has always been found in the pursuing of a theory to its logical conclusions, and there is one result of the electromagnetic theory of light which has not, in my opinion, received the share of attention which it deserves.

When sound passes through air it is propagated more quickly with the wind than against it, and we may easily find the velocity relative to the earth by combining the ordinary sound velocity with the velocity of the wind. Similarly, when any waves pass through a medium moving with uniform velocity, the waves being due to internal stresses in the medium, we may treat of the velocity of the waves independently of that of the medium, and say that the wave-velocity in the direction of motion of the medium, and relative to a fixed body, is the sum of the wave-velocity, calculated on the supposition that the medium is at rest and the velocity of the medium. Prof. J. J. Thomson,[1] applying Maxwell's equations, has arrived at a different result for electromagnetic waves, and has come to the conclusion that in order to get the velocity of light along a stream of flowing water we have to add to the velocity of light only half the velocity of water. The following considerations suggest themselves to me with respect to this result. Maxwell's theory is founded on certain observed effects, which all depend on the relative motion of matter. A result such as the one referred to implies actions depending on absolute motion, and appears therefore to point to something which has been introduced into the equations for which there is no experimental evidence. The only assumption clearly put down by Maxwell is that electromagnetic actions are transmitted through the medium, and it is possible that that assumption necessarily carries Prof. J. J. Thomson's result with it. If a careful examination of the subject should show that this is the case, we are brought face to face with a serious difficulty. It is said, with justice, to be one of the great advantages of Maxwell's theory that it does away with action at a distance; but what do we gain if we replace action at a distance by something infinitely more difficult to conceive, namely, internal stresses of a medium depending on the velocity of the medium through space? I can only see one loophole through which to escape, namely, that Maxwell's medium is not homogeneous, but consists of two parts, and that if we speak of the medium as moving, we mean the motion of one of these parts relative to the other.

While we may hope to obtain important results from an investigation of the relation between what we call electricity and the medium, we must not lose sight of another avenue, namely, the relation between electricity and chemical effects. The passage of electricity through gases presents us with a complicated problem to which a number of physicists have given their attention of late years. There seems no reasonable doubt that electricity in a gas is conveyed by the diffusion of particles conveying high charges, probably identical with those carried by the electrolytic ion. The fact that this convection is a process of diffusion with comparatively small velocity is shown by the experimental result that the path of the discharge is affected by any bodily motion of the gas which conveys the current. Even the convection currents due to the heat produced by the discharge itself are sufficient to deflect the luminous column which marks the passage of the current.

The most puzzling fact, however, connected with the discharge of electricity through gases consists in the absence of symmetry at the positive and negative poles. There must be some difference between a positively and negatively charged atom which seems of fundamental importance in the relation between matter and what we call electricity. A discussion of the various phenomena attending the discharge of electricity through gases seems to me to point to a conclusion which may possibly prove a step in the right direction.

A surface of separation between bodies having different conductivities becomes electrified by the passage of a current, while at the surface between two chemically distinct bodies we have, according to Helmholtz, a sheet covered at the two sides with opposite electricities. These surface electrifications are not merely imaginary layers invented to satisfy mathematical surface conditions. They can be proved to be realities. Thus, when one electrolyte floats on another, the specific resistances being different, we often observe secondary chemical effects due to the action of the ions which carry the surface electrification.

If the passage of electricity from the solid to the gas involves some work done, we must expect a double sheet of electricity at the boundary, the gas in contact with the kathode becoming positively, and that in contact with the anode negatively, electrified. *A priori* we can form no idea how a layer of gas, the atoms of which carry charges, will behave. The ordinary proof that all electrification must be confined to the surface implies that all forces act according to the law of the inverse square, but where we have also to consider molecular forces, I see no reason why the electrification at a surface may not stretch across a layer having a thickness comparable with the mean free path of the molecule. It is here that there seems to be the fundamental difference between positive and negative electricity. A negative electrification of the gas, like that of a solid or a liquid, seems always confined to the surface, and no one has ever observed a volume electrification of negative electricity. The case is different for the positively electrified part of the gas. Wherever from other considerations we should expect a positively electrified surface sheet, we always get a layer of finite thickness. The result implies a different law of impact between positively and negatively electrified ions, but I see no inherent improbability in this. That the kathode let into a gas is surrounded by a positively electrified layer of finite thickness extending outwards must be considered as an established fact, and several of the characteristic features of the discharge are explained by it. The large fall of potential at the kathode can also be explained on the view which I have put forward, for in order to keep up the discharge there must be a sufficient normal force at the surface, and if this force is not confined to the surface, but necessarily stretches across a finite layer, the fall of potential must be multiplied a great number of times. Similarly Goldstein has shown that some of the phenomena of the kathode are observed at every place at which the positive current flows from a wide to a narrow part of a column of gas. At such places we should expect a positive surface electrification, and here, again, the whole appearance tends to show that we are dealing with a positive volume electrification. No corresponding phenomena are observed when the current passes from the narrow to the wide part.

The fact that in all cases experimented upon positive volume electrifications are observed but never similar negative electrifications is surely of significance.

Some of the results recently brought to light by investigations on the discharge of electricity have interesting cosmical applications. Thus it is found that such a discharge through any part of a vessel containing a gas converts the whole gas into a conductor.[1] The dissociation which we imagine to take place in a liquid before electrolytic conduction takes place must be artificially produced in a gas by the discharge itself. We may imitate in gases which have thus been rendered conductive many of the phenomena hitherto restricted to liquids: thus I hope to bring to the notice of this meeting cases of primary and secondary cells in which the electrolyte is a gas. There are other ways in which a gas can be put into that sensitive state in which we may treat it as a conductor, and we have every reason to suppose that the upper regions of our atmosphere are in this state. The principal part of the daily variation of the magnetic needle is due to causes lying outside the surface of the earth, and is in all probability only an electro-magnetic effect due to that bodily motion in our atmosphere which shows itself in the diurnal changes of the barometer. A favourite idea of the late Prof. Balfour Stewart will thus probably be confirmed. The difference in the diurnal range between times of maximum and times of minimum sun-spots is accounted for by the fact that the atmosphere is a better conductor at times of maximum sun-spots.

The mention of sun-spots raises a point not altogether new to this section. Careful observation of celestial phenomena may suggest to us the solution of many mysteries which are now puzzling us. Consider, for instance, how long it would have taken to prove the universal property of gravitational attraction if the record of planetary motion had not come to the philosopher's help. And surely the most casual observation of cosmical effects teaches us how much we have yet to learn.

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[1] *Phil. Mag.*, vol. ix. p. 284 (1880).

[1] An experiment by Hittorf (*Wied. Ann.* vii. p. 614) suggested the probability of this fact, which was proved independently by Arrhenius and myself.

The statement of a problem occasionally helps to clear it up, and I may be allowed, therefore, to put before you some questions, the solution of which seems not beyond the reach of our powers.

1. Is every large rotating mass a magnet? If it is, the sun must be a powerful magnet. The comets' tails, which eclipse observations show stretching out from our sun in all directions, probably consist of electric discharges. The effect of a magnet on the discharge is known, and careful investigations of the streamers of the solar corona ought to give an answer to the question which I have put.[1]

2. Is there sufficient matter in interplanetary space to make it a conductor of electricity? I believe the evidence to be in favour of that view. But the conductivity can only be small, for otherwise the earth would gradually set itself to revolve about its magnetic pole. Suppose the electric resistance of interplanetary space to be so great that no appreciable change in the earth's axis of rotation could have taken place within historical times, is it not possible that the currents induced in planetary space by the earth's revolution may, by their electromagnetic action, cause the secular variation of terrestrial magnetism? There seems to me to be here a definite question capable of a definite answer, and as far as I can judge without a strict mathematical investigation the answer is in the affirmative.

3. What is a sunspot? It is, I believe, generally assumed that it is analogous to one of our cyclones. The general appearance of a sunspot does not show any marked cyclonic motion, though what we see is really determined by the distribution of temperature and not by the lines of flow. But a number of cyclones clustering together like the sunspots in a group should move round each other in a definite way, and it seems to me that the close study of the relative positions of a group of spots should give decisive evidence for or against the cyclone theory.

4. If the spot is not due to cyclonic motion, is it not possible that electric discharges setting out from the sun, and accelerating artificially evaporation at the sun's surface, might cool those parts from which the discharge starts, and thus produce a sunspot? The effects of electric discharges on matters of solar physics have already been discussed by Dr. Huggins.

5. May not the periodicity of sunspots, and the connection between two such dissimilar phenomena as spots on the sun and magnetic disturbances on the earth, be due to a periodically recurring increase in the electric conductivity of the parts of space surrounding the sun? Such an increase of conductivity might be produced by meteoric matter circulating round the sun.

6. What causes the anomalous law of rotation of the solar photosphere? It has long been known that groups of spots at the solar equator perform their revolution in a shorter time than those in a higher latitude; but spots are disturbances which may have their own proper motions. Duner[2] has shown, however, from the displacement of the Fraunhofer lines, that the whole of the layer which produces these lines follows the same anomalous law, the angular velocity at a latitude of 75° being 30 per cent. less than near the equator.[3] As all causes acting within the sun might cause the angular velocity of the sun to be smaller at the equator than at other latitudes, but could not make it greater, the only explanation open to us is an outside effect either by an influx of meteoric matter, as suggested by Lord Kelvin, or in some other way. If we are to trust Dr. Welsing's result that faculæ which have their seat below the photosphere revolve in all latitudes with the same velocity, which is that of the spot velocity in the equatorial region, we should have to find a cause for a retardation in higher latitudes rather than for an acceleration at the equator. The exceptional behaviour of the solar surface seems to me to deserve very careful attention from solar physicists. Its explanation will probably carry with it that of many other phenomena.

In conclusion, I should like to return for an instant to the question whether it is possible by any means to render the progress of science more smooth and swift. If there is any truth in the idea that two types of mind are necessary, the one corresponding to the boiler and the other to the cooler of a steam-engine, it must also be true that some place must be found where the two may bring their influence to bear on each other. I venture to think that no better ground can be chosen than that supplied by our meetings. We hear it said that the British Association has fulfilled its object; we are told that it was originally founded to create a general interest in scientific problems in the towns in which it meets; and now that popular lectures and popular literature are supposed to perform that work more satisfactorily, we are politely asked to commit the happy despatch. There is no need to go back to the original intention of those who have founded this institution, which has at any rate adapted itself sufficiently well to the altered circumstances to maintain a beneficial influence in scientific research.

The free discussion which takes place in our sections, the interchange of ideas between men who during the rest of the year have occupied their minds, perhaps too much, with some special problem, the personal intercourse between those who are beginning their work with sanguine expectations, and those who have lost the first freshness of their enthusiasm, should surely one and all ensure a long prosperity to our meetings. If we cannot claim any longer to sow the seeds of scientific interest in the towns we visit, because the interest is established, we can at any rate assure those who so kindly offer us hospitality that they are helping powerfully in the promotion of the great object which we all have at heart.

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY PROF. HERBERT McLEOD, F.R.S., F.C.S., PRESIDENT OF THE SECTION.

IN endeavouring to prepare myself to properly fulfil the duties of President of this Section, to which I have been elected, and for which honour I am much indebted to the council and members of the Association (although I am only too well aware that the position might have been more efficiently filled by many others), I naturally looked at the reports of the previous meetings held in Edinburgh in 1834, 1850, and 1871, and it appears that on the first two occasions an address was not given by the president, a custom the discontinuance of which I have, at the present moment, much reason to regret.

At the meeting in 1834 a committee was appointed consisting of Dr. Dalton, Dr. Hope, Dr. T. Thomson, Mr. Whewell, Dr. Turner, Prof. Miller, Dr. Gregory, Dr. Christison, Mr. R. Phillips, Mr. Graham, Prof. Johnston, Dr. Faraday, Prof. Daniell, Dr. Clark, Prof. Cumming, and Dr. Prout, to report at the next meeting their opinion on the adoption of an uniform set of chemical symbols. Dr. Turner to be secretary.

In the following year the report contains: "Report of the Committee on Chemical Notation. Dr. Turner, the chairman of the committee appointed to take into consideration the adoption of an uniform system of chemical notation, made a report to the following effect:—

"1. That the majority of the Committee concur in approving of the employment of that system of notation which is already in general use on the Continent, though there exists among them some difference of opinion on points of detail.

"2. That they think it desirable not to deviate in the manner of notation from algebraic usage except so far as convenience requires.

"3. That they are of opinion that it would save much confusion if every chemist would always state explicitly the exact *quantities* which he intends to represent by his symbols.

"Dr. Dalton stated to the Chemical Section his reasons for preferring the symbols which he had himself used from the commencement of the atomic theory in 1803, to the Berzelian system of notation subsequently introduced. In his opinion regard must be had to the arrangement and equilibrium of the atoms (especially elastic atoms) in every compound atom, as well as to their number and weights. A system either of *arrangements* without *weights*, or of *weights* without *arrangements*, he considered only half of what it should be."

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[1] The efforts of Mr. Bigelow have a bearing on this point, also some remarks which I have made in a lecture before the Royal Institution (*Proc. Roy, Inst.* 1891), but nothing decisive can be asserted at present.

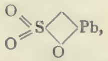
[2] Oefvers. af Kongl. Veterrk. Ak. Forhandl., 47, 1890.

[3] Although the importance of M. Duner's results would make an independent investigation desirable, the measurements of Mr. Crew, who by a much inferior method arrived at other results, cannot have much weight as compared with those of Duner.

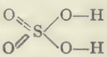
We can all sympathize with the members of the section of 1834 in their desire to obtain an uniform system of chemical notation, for at that time several very different systems seem to have been in use. Although the report is a short one, it probably directed the attention of chemists to the desirability of avoiding confusion by the use of various systems, and since that period many advances have been made.

There is now little necessity for every chemist to "state explicitly the exact *quantities* which he intends to represent by his symbols" for the accurate determinations of atomic weights by many chemists—and we must not omit to mention the work of Stas (whose death we have had to deplore since the last meeting of the British Association)—have given us a series of numbers which are in the hands of all chemists, so that, except in the cases where great refinement is requisite (or when the atomic weight has not been universally accepted) there is no need to state the values of the symbols.

That great advances have been made in chemical notation is well known to all; even in my own short experience I have had to learn several different methods. When I began to work at chemistry I was told that sulphate of lead was to be expressed by the formula PbO,SO_3. Hofmann taught me that it should be $PbSO_4$; then Gerhardt doubled the atomic weights of oxygen and sulphur and the formula became Pb_2SO_4; Cannizzaro showed that the atomic weight of lead should also be doubled, and the formula again became $PbSO_4$, but representing twice as much as formerly; then Frankland taught me to write SO_2Pbo'' as the expression of the graphic formula—



which not only states that the compound contains 207 of lead, 32 of sulphur, and 64 of oxygen, but that the sulphur is hexad, and is combined with two atoms of dyad oxygen, and with a dyad compound radical containing one atom of lead and two of oxygen; and of all the formulæ just given this is the only one which satisfies the requirements which Dalton thought necessary in 1835, namely, to indicate not only the weights of the elements present, but also their arrangement. It may be objected that we do not know that this formula really represents the arrangements of the atoms in plumbic sulphate, but there can be very little doubt that the four atoms of oxygen in the compound are not all in the same condition, for if we examine the properties of sulphuric acid (from which the sulphate of lead is derived by the replacement of the hydrogen by lead), we find that two of the atoms of oxygen are more closely associated with the hydrogen than are the other two, and, as there is some evidence, although perhaps not very conclusive, that sulphur may be capable of combining with six monad atoms, although no such compound is yet known, it does not seem unreasonable to suppose that sulphuric acid is really:—



What the nature of the attraction that holds the atoms together may be is not known, but it is more probably of a character similar to that of gravity which holds together sun and planets, than of the nature of cohesion which would hold the atoms rigidly together; the atoms in each molecule are therefore most probably in a state of rotation around, or of vibration to and from, the central atom which holds them together. The pictorial representation in a plane does not therefore truly express the position of the atoms, but merely the relations existing between them. In organic chemistry the use of formulæ expressing such a relation has become indispensable, and in inorganic chemistry I believe such a system is very useful.

Recently this system has been found insufficient for the requirements of organic chemistry, and recourse has been had to the figure of a tetrahedron to represent the atom of carbon, other atoms being attached to the solid angles; in this way the position of the atoms in space is more or less expressed.

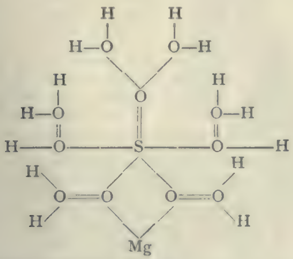
There are many cases, however, in which the atomicity theory fails us. At first it seemed probable that the atomicity of an element varied in pairs of attractions, that is, an element might be monad, triad, or pentad, but not dyad or tetrad; or it might be dyad, tetrad, or hexad, but not triad or pentad; but some great difficulties have been encountered. Thus nitrogen, which is pentad in ammonic chloride and triad in ammonia, forms the compound nitric oxide, NO, in which it would appear to be dyad; it has been suggested, however, that in this body the nitrogen is really triad, and that it possesses a "free bond." Now the idea of a "free bond" seems contrary to the principles of atomicity, since it is on the belief that such a free bond is impossible that the explanation of the existence of elementary molecules is formed, for it is said that when hydrogen is liberated two atoms unite to form a molecule, so that their mutual attractions may be satisfied. Nevertheless nitric oxide is a very active body, uniting readily with other substances, so the free bond seems to be on the look out for other kinds of matter, but to have no attraction for the free bond of another molecule of nitric oxide. As the molecule of nitric peroxide is variable by alterations of temperature, being N_2O_4 at low and NO_2 at high temperatures, it seemed not impossible that at the ordinary atmospheric temperature nitric oxide was a simplified or dissociated molecule, and that if the temperature were sufficiently reduced it would be found that its molecule would be N_2O_2, and thus it would contain triad nitrogen without a free bond. The density of the gas has, however, been determined at a temperature as low as $-73°$ and the molecule is still NO. Another important exception to the variation of the atomicity of an element in pairs was furnished by the investigations of Sir Henry Roscoe on the chlorides of vanadium; this element which, from analogy, should be a triad or a pentad, appears to form a chloride of the composition VCl_4. Again, the molecule of peroxide of chlorine is ClO_2, which would make chlorine a tetrad or the compound must have a free bond.

Another set of phenomena which the atomicity theory will not explain is the existence of well-defined crystalline salts containing what is called water of crystallization. This water is in many cases held with considerable pertinacity, the body appearing to be a veritable chemical compound. But water appears to be a saturated body, the attractions of the oxygen being satisfied by those of the hydrogen. It is true that water acts vigorously on other compounds, as on metallic oxides to form hydrates, and on some anhydrides to form acids, but these appear to be phenomena of double decomposition; thus the combination of water with sodic oxide and nitric anhydride respectively may be expressed by the equations

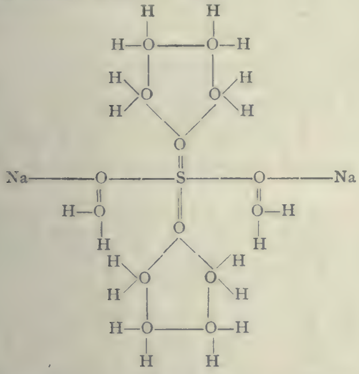
$$OH_2 + ONa_2 = OHNa + ONaH \text{ and}$$
$$OH_2 + O(NO_2)_2 = OH(NO_2) + O(NO_2)H.$$

In the combination of water with an anhydrous salt, a phenomenon often accompanied by great rise of temperature, there does not appear to be a double decomposition. That there is a chemical combination of some sort is shown by the changes of properties produced, crystalline form and colour being both sometimes altered. Compounds so produced have been called "molecular compounds" to imply that saturated molecules are in some way or another combined, the combination being different from "atomic combination," in which the atoms are directly united according to their valencies. Another explanation has been suggested by assuming that there is some "residual affinity" not saturated by the constituents of the body, and that this residual affinity enables bodies to unite in a less stable manner than in most compounds. But are not these terms—"molecular combination" and "residual affinity"—analogous to the term "catalysis," merely *words* to express—not to explain—what we do not understand? If "residual affinity" really exists, it must reside in the oxygen of the water, or in the hydrogen, or both; if so, what will happen to some of the complex constitutional formulæ of the organic chemist in which the carbon is tetrad, the oxygen dyad, and the hydrogen monad? If any of these elements have a residual affinity should we not expect to find additional unions between some of the atoms of the same molecule over and above those represented by the formula?

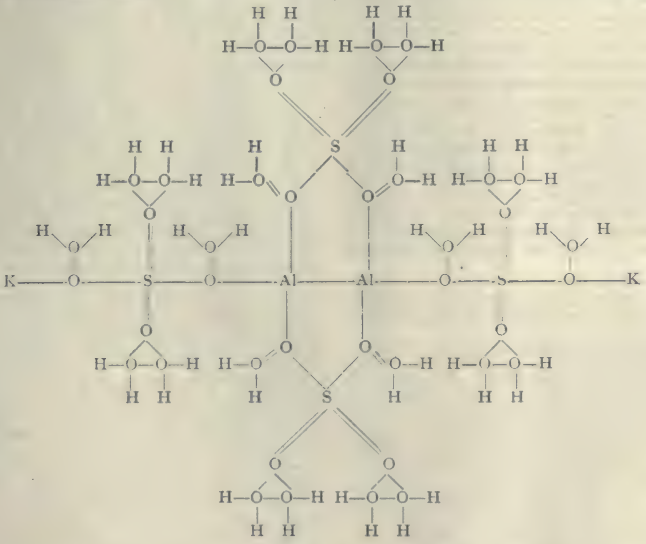
Oxygen may be tetrad, for which there is evidence in OAg_4. Under these circumstances water is by no means a saturated compound, and there would be no difficulty in explaining the combination of water with oxygen salts. Thus crystallized magnesic sulphate, $MgSO_5$, $7OH_2$ or SOHoMgo″, $6OH_2$ would be—



and sodic sulphate, Na_2SO_4, $10OH_2$:—



Even alum, with its 24 molecules of water of crystallization, may be expressed by an appalling formula :—



There is certainly a symmetry about the formula, and it will be found that 16 of the molecules of water are in a different position from the remaining 8 ; this probably has no significance, although Graham found that crystallized alum at a temperature of 61° lost 18 molecules of water ; if he had used a temperature a few degrees lower he might have found that only 16 passed off !

By a little stretching of the imagination and altering the atomicities of the elements to suit each particular case, no doubt graphic formulæ might be made for all crystalline salts, but they would be perfectly artificial, and not much good is likely to come from the attempt.

I fear we are driven to the conclusion, that, notwithstanding all the progress that has been made in chemical science during the last fifty-eight years, we have not yet reached a method of notation that would have satisfied Dr. Dalton in 1834.

But since that time we have learnt that our formulæ ought to show even more than the number and position of the atoms of a compound ; we should like them to indicate the amount of potential energy residing in a body, and our equations ought to indicate the amount of heat generated by a chemical change. Let us hope that before the next meeting of the British Association in Edinburgh these desirable developments will have been accomplished.

A short time ago I mentioned the word catalysis as being employed to express certain chemical actions which cannot be explained. It is applied to those phenomena which take place in the presence of a body which appears to be entirely unchanged by the action. Happily these catalytic actions are being explained one after another, so that soon the name itself may become obsolete. An example of this action of presence may be given. When a mixture of sulphuric acid and alcohol is heated to a temperature of about 140° to 150°, ether passes over. Now alcohol contains C_2H_6O, and if from two molecules of alcohol one molecule of water is subtracted a molecule of ether results :—$2C_2H_6O = OH_2 + C_4H_{10}O$. As sulphuric acid is known to have a great attraction for water, it is easy to imagine that the acid combines with the water and ether passes off. But it is found that a small quantity of sulphuric acid at the temperature of 140° – 150° will transform a very large amount of alcohol into ether and water, much more than can be explained by assuming that the acid has combined with the water. If a mixture of sulphuric acid and alcohol is heated to a temperature of 140° – 150°, and alcohol allowed to flow into the liquid, a mixture of ether and water vapours passes over, and after a large quantity of alcohol has been transformed, the amount of sulphuric acid is found to be unaltered. At first glance this seems very difficult to explain, but on further investigation it is found that alcohol and sulphuric acid act one on another to form ethyl-sulphuric or sulphovinic acid:—

$$SO_2Ho_2 + EtHo = SO_2HoEto + OH_2$$

but when ethyl-sulphuric acid is heated with alcohol, ether is formed with the reproduction of sulphuric acid—

$$SO_2HoEto + EtHo = OEt_2 + SO_2Ho_2$$

the sulphuric acid is then able to produce ethyl-sulphuric acid by acting on more alcohol, so a continuous production of ether and water takes place without loss of sulphuric acid. Another well-known action is the combination of oxygen and hydrogen under the influence of spongy platinum. In this case the platinum remains apparently unaltered, and is capable of causing the combination of any quantity of mixed gases. As spongy platinum possesses the power of absorbing large quantities of gases, it is usually said that the molecules of oxygen and hydrogen are so much condensed in the platinum that they are brought within the sphere of one another's attractions, and consequently combine.

Another instance of an action of this kind is afforded by the oxidation of ammonia in the presence of chromic oxide. When ammonic dichromate is heated an evolution of gas occurs, and a residue of chromic oxide is left which bears a striking resemblance to a mixture of black and green tea; when some of this substance is placed on a piece of wire gauze, heated and then supported over a vessel containing a strong solution of ammonia, the oxide glows in a manner similar to the glowing of spongy platinum under the influence of a mixture of hydrogen and air. Under these conditions the chromic oxide facilitates the oxidation of the ammonia, but it becomes changed during the process; instead of having the appearance above described, it acquires a bright green colour. Now, we know that chromium is capable of forming several combinations with oxygen. Is it therefore too much to suppose that the chromium is alternately oxidized by the oxygen of the air, and reduced by the hydrogen of the ammonia, so that, although in the end it has the same composition as at the beginning, nevertheless it has been continuously decomposed and reproduced? Now, may not a similar change take place during the action of spongy platinum on a mixture of hydrogen and oxygen? The alteration of the platinum is very slight, but I believe I have observed a slight modification of the appearance of a fragment of spongy platinum that was kept glowing by a small jet of purified hydrogen for some hours; the gas not being allowed to burn so as to heat the platinum to a very high temperature, the metal appears to be compacted and to be covered by minute spherules of glistening metal. Now, may not the platinum have entered into combination with one or other of the gases and been subsequently reduced? If this is the true explanation, then we have in this case a continuous series of chemical changes and the "catalysis" is explained.

We all know the ease with which oxygen is obtained from potassic chlorate when heated with a small quantity of oxide of manganese; the quantity of peroxide is the same at the end of the process as at the beginning, and it may be used over and over again to assist in the decomposition of fresh potassic chlorate. The oxide of manganese undergoes a molecular alteration; if a crystalline variety is employed, it is found, at the end of the process, to have been transformed into fine powder.

I hope I have proved to the satisfaction of my brother chemists that potassic permanganate is first formed and subsequently decomposed with the reproduction of manganese peroxide.

Oxide of cobalt possesses the remarkable property of decomposing solutions of hypochlorites at moderate temperatures with evolution of oxygen. For some time I have been endeavouring to find the explanation of the change, but hitherto without complete success. At first it seemed probable that an unstable cobaltate, analogous to a ferrate, was formed and decomposed at the temperature of the experiment. In fact oxygen is evolved when chlorine is passed through a boiling solution of sodic hydrate containing ferric hydrate in suspension. But no evidence of the existence of a cobaltate could be found. When a cobaltous salt is added to an alkaline solution of a hypochlorite, a black precipitate is formed which is usually stated to be cobaltic hydrate, Co_2Ho_6, but Vortmann has shown that, when a cobaltous salt is mixed with a solution of iodine in potassic iodide, and the liquid rendered alkaline by sodic hydrate, the precipitate formed at a temperature between 50° and 60° approaches in composition the dioxide of cobalt, CoO_2. He also found that the precipitate lost oxygen at the temperature of boiling water. I have repeated some of his experiments and can quite confirm them, although I have not obtained an oxide containing quite as much oxygen as his richest oxide. The oxides I prepared rapidly effected the decomposition of a solution of sodic hypochlorite, and that without undergoing any loss of oxygen themselves; in fact, in the two experiments made, the cobalt compound contained a little more oxygen after boiling with the hypochlorite.

We have now many instances of the influence which small quantities of substances have upon chemical reactions. These influences may be more common than is generally supposed. The presence of a third body is frequently helpful in the combination of elements with one another: thus dry chlorine will not attack melted sodium or finely divided copper; an electric spark will not cause a dry mixture of carbonic oxide and oxygen to explode; carbon, phosphorus, and sulphur will not unite with dry oxygen, and as chemical science progresses we may find that many well-known actions are conditioned by the presence of minute traces of other matter which have hitherto escaped detection. We all know the profound alterations of the properties of substances by minute traces of impurities; less than one-tenth per cent. of phosphorus will render steel unfit for certain purposes. The sapphire and ruby only differ from colourless alumina by the presence of traces of impurities hardly recognisable by chemical analysis. During this meeting we hope to have a contribution to the section on the influence of minute traces of what may be called impurities on the properties of different substances and their influence on chemical changes.

In this city, where the first public chemical laboratory was started in 1823, by Dr. Anderson, the assistant of Prof. Hope, it is hardly necessary to insist on the extreme importance of teaching chemistry by practical work, but unfortunately, even at the present time, endeavours are made to teach the subject by means of lectures (sometimes without experiments) or by reading. Those who are acquainted with chemistry well know the impossibility (this is hardly too strong a word) of learning the science, especially in the first stages, without actual experiment, by which a practical acquaintance with chemical phenomena is obtained. The attempt to learn chemistry without practical experience reminds one of the well-known story (for the truth of which I will not vouch) of a mathematician who lectured on natural philosophy; he was visiting a foreign laboratory, and stopped before a piece of apparatus and asked what it was: on being told it was an air-pump, he exclaimed, "Dear me! I have lectured on the air-pump for twenty-five years, and this is the first time I have seen one." It is problematical if his students can have derived much advantage from his lectures. Teaching of the kind to which reference has just been made is generally given to candidates for examinations who do not intend to take up chemistry as their chief subject. At the present time chemistry is required for entrance and preliminary examinations from many classes of students. There is no doubt that it is an excellent means of education, teaching a boy to observe and draw conclusions from his observations; but if he makes no observations it is little more than useless cram, the memory might as well be exercised by learning a novel by heart.

This imperfect mode of teaching chemistry arises principally from the difficulty of obtaining properly appointed laboratories in schools, in addition to which the very strong fumes are sometimes disagreeable, making it inconvenient to have them in or near a house, to say nothing of the possible dangers to the clothes and their contents; but there is no help for it, the teaching must be accompanied by experimental demonstration, as was indicated in the Reports on the teaching of chemistry which have been presented to this Association in former years. It must be admitted that examinations do not always discover the best student; many are capable of preparing for examinations with a small knowledge of their subject, others, with a good knowledge, fail from nervousness or other causes, but at the present time examination, though far from perfect, is almost the only means we have of judging the fitness of the candidate. By properly selecting questions the examiner may, to a considerable extent, discourage cram; he should endeavour to find out what the pupils have actually seen, and to make them draw conclusions from facts which they have either themselves observed, or which have been described to them; it is only in this manner that chemistry can be used as a means of mental training.

These remarks do not apply to the education of students intending to make chemistry their profession, who have many opportunities, in the large laboratories of Great Britain and the Continent, of obtaining all the necessary instruction. The Institute of Chemistry, which was founded to improve the status and also the education of professional chemists, requires that its members should have a thoroughly scientific training. Before a candidate for the associateship is admitted to examination, he must bring evidence that he has passed satisfactorily through a systematic course of at least three years' study in the subjects of theoretical and practical chemistry, physics, and elementary mathematics, in some recognized college or school; and before admission to the fellowship he must have passed through three additional years of work in chemistry. It is to be hoped that an example of this kind will ultimately have a good effect in improving the modes of teaching the science in its elementary stages.

There is another class of workers in chemistry who must not be forgotten at the present time, as they have much influence on the life of the world and have been working for ages, but have only recently been recognized. I mean those organisms which are included under the name of microbes. These organisms are capable of producing chemical changes which entirely surpass all the results hitherto obtained by the chemist in his laboratory. That the transformation of sugar into alcohol and carbonic anhydride in the ordinary process of fermentation is due to a living organism, has been known for some years; the important transformation of ammonia into nitrous and nitric acids in the soil has been shown to be due to organisms which have recently been investigated by many chemists; it is possible to transform ammonia into these acids in the laboratory by oxidation under certain conditions and at a high temperature, whereas the organism does the work quite as efficaciously at the common temperature. Other organisms have the power of producing complex organic poisons by the alteration of some of the constituents of the animal body, and the relation of these products to the study of diseases is of the highest possible importance. As we hope to have a discussion on this interesting subject by many eminent authorities, both from the chemical and biological points of view, it will be unnecessary to pursue the subject further, unless it be to urge some of the younger chemists to work at the chemical aspect of bacteriology. They must be prepared for hard work and many disappointments, for the subject is undoubtedly a difficult one.

I cannot conclude this address without reference to the great loss which chemistry has sustained by the death of Prof. A. W. von Hofmann. I had the good fortune to be under him as student and assistant from 1856 until he left this country in 1865; all who worked with him must have been deeply impressed by his capacity for work and his power of inducing work in others. Although perhaps some of us did not appreciate this at the time, yet we feel we owe him a debt of gratitude for his having started us in the right way. The list of papers under his name in the Royal Society Catalogue up the year 1883 is 299, written by himself alone, besides twenty-two joint papers. One of his characteristics which impressed me was his investigation for the purpose of furthering chemical knowledge without any view to practical applications, and I well remember his lecture at the Royal Institution, in 1862, on Mauve and Magenta (which owed so much of their success to his work), in which he produced the original specimen of benzene which had been obtained by Faraday from oil-gas in 1825. He pointed out that Faraday had prepared this substance and investigated its properties without ever supposing that it could have any practical application. The following is the concluding paragraph of the lecture:—

"Need I say any more? The moral of Mauve and Magenta is transparent enough; I read it in your eyes. We understand each other. Whenever in future one of your chemical friends, full of enthusiasm, exhibits and explains to you his newly-discovered compounds, you will not cool his noble ardour by asking him that most terrible of all questions, 'What is its use? Will your compound bleach or dye? Will it shave? May it be used as a substitute for leather?' Let him quietly go on with his work. The dye, the lather, the leather will make their appearance in due time. Let him, I repeat, perform his task. Let him indulge in the pursuit of truth—of truth pure and simple—of truth not for the sake of Mauve, not for the sake of Magenta, let him pursue truth for the sake of truth."

This seems to me the true spirit of the scientific investigator and in many cases the reward consists solely in the consciousness that the investigator has done his duty; in some cases the reward may take a more substantial form, and since the above paragraphs were written I have been informed that Prof. von Hofmann has left a large fortune, the result of the applications of his discoveries in technical chemistry.

NOTES.

WE hope to publish shortly, in the series of "Scientific Worthies," a portrait of Sir Archibald Geikie, whose address as president of the British Association we print to-day. The portrait will be accompanied by a sketch of Sir Archibald's career as a man of science.

THE International Congress of Experimental Psychology began work at University College, Gower Street, on Monday, when an address was delivered by Prof. H. Sidgwick. We propose to give on a future occasion some account of the proceedings.

THE Helvetic Society of the Natural Sciences will hold its seventy-fifth annual meeting at Basel from September 5 to 7. The Basel Society of the Natural Sciences will celebrate its seventy-fifth anniversary at the same time.

MR. J. BRETLAND FARMER, M.A., Fellow of Magdalen College, Oxford, and Demonstrator of Botany in the University, has been appointed Assistant-Professor in Botany at the Royal College of Science, London, as successor to Dr. D. H. Scott, who becomes Honorary Keeper of the Jodrell Laboratory, at the Royal Gardens, Kew.

MR. H. M. BERNARD, M.A., has been elected to the Marshall Scholarship, Royal College of Science, South Kensington, for the ensuing year, in place of Mr. G. Biebner, whose term of office has expired.

MR. J. P. HILL, of the Royal College of Science, South Kensington, and the University of Edinburgh, has been appointed to the Demonstratorship of Biology in the University of Sydney.

MR. SILVA WHITE has, for reasons of health, resigned his office as secretary and editor to the Royal Scottish Geographical Society, a post he has filled since the institution of the society.

WE regret very much to hear of the death of Dr. H. J. Tylden, whose article on "The bearing of pathology upon the doctrine of the transmission of acquired characters" was printed in NATURE last week. At the beginning of last week he died of typhoid fever. Dr. Tylden had been engaged in investigating the etiology of typhoid fever, and there is no doubt that he thus contracted the disease.

TWO eminent men who had been intimately connected with India died last week—Dr. Forbes Watson and Dr. H. W. Bellew. Dr. Bellew was well known as an Oriental linguist and as the author of various works in which he made important contributions to ethnology. Dr. Forbes Watson acted for many years as Reporter on the Products of India and Director of the India Museum. He did much to give the English people a wider and more accurate knowledge both of the races and the material resources of India.

THE death of Dr. Felice Giordano, of Rome, is announced. He was the head of the Geological Survey of Italy and Chief Inspector of Mines.

THE Glasgow and West of Scotland Technical College has issued its calendar for the year 1892-93.

ON July 27 the eruption of Mount Etna, which on the previous day had increased considerably in activity, was again as violent as during the first few days of the outbreak. Rocks and masses of volcanic *débris* were ejected from the crater to a great height, as well as a quantity of fine ash, which fell in showers over the country. The cloud of smoke over the summit increased, and the subterranean rumblings were so loud and frequent as to make the windows in the houses rattle. The lava streams were also extending. Similar reports were issued on the three following days; but on July 31 a general decrease in the volume of the lava was noted. On August 1 it was stated that the eruption seemed to be subsiding. No underground rumblings were heard, the smoke issuing from the crater was white, and the lava streams moved very slowly, and, in fact, almost stopped. On August 2 the volcano showed some signs of renewed activity, and the lava streams began to flow afresh. The underground rumblings were not, however, so loud as before.

SOME information as to the volcanic eruption in Great Sangir is given in letters sent from Menado, the chief Dutch settlement in the north of the Celebes, from which Sangir is about 300 miles distant. The letters are dated June 12, and were printed in the *Handelsblad*, of Amsterdam, on July 27. According to a summary in a Reuter's telegram, the disaster came with appalling suddenness. At ten minutes past six on the evening of June 7, unannounced by the slightest shock of earthquake, subterranean rumblings, or other seismic warning, a terrific eruption began from the great volcano Gunona Awa, which is not far from Tarvena, the capital of the island. Ashes in immense masses and stones of considerable size soon fell all over the island. Hundreds were killed by this shower, and even those who reached the shelter of their homes were not safe, for nearly everywhere in the country districts the light wooden houses collapsed under the weight of the stones and ashes which quickly settled on the roofs. In the immediate vicinity of the mountain, on the slopes of which are numerous farms and villages with extensive plantations, immense destruction was caused by the great streams of lava, which flowed with astonishing rapidity down into the surrounding valleys. Houses were carried away with all their contents, and many of the occupants met a terrible death in these rivers of molten rock. Besides the hundreds who are known to have lost their lives on the lowlands, between five hundred and a thousand more who were engaged in the rice-fields on the mountain slopes have not been heard from. The crops have been destroyed, the cocoa-nut trees have suffered severely, and in many parts of the island the wells have become dry.

AT the time of our last issue the weather was very settled, and the air very dry, scarcely any rain having fallen for some days. On Friday, however, July 29, the anticyclone began to give way, and the low pressure over the Bay of Biscay extended northwards and over the eastern parts of England, causing thunderstorms in the southern counties. By Sunday, the disturbed weather had extended over the whole country, and rain had fallen at most places, but the area of low barometer was passing away to the eastward, and during the early part of this week the type of weather again became anticyclonic generally, but the sky became cloudy, and rain fell in places; while on Wednesday a depression lay over the North of Scotland, which appeared likely to spread southwards. Temperatures have ranged from 70° to 75° and upwards in the southern districts, but have been considerably lower in the north; the daily maxima frequently not reaching 60°. The *Weekly Weather Report* showed that for the week ending July 30 the temperature only slightly exceeded the average in the North of Scotland. Rainfall was much below the mean, amounting to six to nine-tenths of an inch in most districts, while reckoning from the beginning of the year there is a deficit in every district, amounting to as much as 7·4 inches in the south-west of England.

THE Austrian Meteorological Society has issued an appeal for contributions towards the support of the meteorological observatory on the summit of the Sonnblick. The observatory was established by M. Rojacher in 1886, and completed at the expense of the Austrian Society and the German and Austrian Alpine Club; it has since been maintained at the expense of these two institutions, together with a subvention from the Ministry of Instruction, and aided by a small reserve from the original building fund. The recent death of M Rojacher, and the removal of the Alpine Club from a house on the summit, has thrown such additional expense on the Austrian Society as to endanger the efficient maintenance of the Observatory. The station has already rendered good service to science and has somewhat modified the theory of the nature and origin of storms; several physicists have also conducted experiments there on radiation, atmospheric electricity, and other subjects of considerable importance. We hope, therefore, that the appeal of the Society for funds for the efficient maintenance of the station will meet with entire success.

THE trustees of the South African Museum, in their report for the year 1891, record a serious loss in the mineralogical series of the Museum's collection. On the night of September 7 and 8 the Museum was robbed of the Stonestreet collection of rough diamonds, a separate diamond in singularly hard rock, and several very interesting nuggets of South African gold. The exhibition hall was broken into through one of the small upper windows opening on the higher of the two galleries, and the specially protected table-case, containing the diamonds and gold, forced by shattering the lock. Two men—whose names, A. McEwen and E. Cohen respectively, were already too well known in the criminal records—were convicted of the robbery at the Supreme Court session on the 13th November, and sentenced to four years' hard labour. The police succeeded in recovering 49 of the 173 diamonds belonging to the Stonestreet collection, including most of the larger stones, but among the missing majority are many unusual and abnormal crystalline forms of much interest, collected with great pains by the late Mr. Stonestreet, during the earlier years of mining in Griqualand West. The Du Toit's Pan diamond in indurated rock and the gold nuggets have not been recovered.

IN the course of an interesting address delivered lately at the opening of the new chemical laboratory of the Case School of Applied Science, Prof. C. F. Mabery called attention to the fact that notwithstanding America's abundant supply of crude materials, with cheap fuel in unlimited quantities, and a ready market with an increasing demand, she continues to pay enormous sums for imported products which should be produced at home. Prof. Mabery thinks, however, that the outlook for the immediate future is encouraging. In several directions the manufacture of chemical products has begun, and others, he believes, will follow. There are certain lines along which rapid development may evidently soon be expected, and one of the most promising is sal-soda. Until quite recently the Le Blanc process, which was invented in France to manufacture soda-ash when the supply from natural sources was largely cut off during the French Revolution, has supplied the world since early in the present century. In utilizing all bye-products the great Le Blanc works of Europe have been able to produce soda-ash at a trifling cost. A Le Blanc plant has never been established in America, and probably one never will be. Such a plant requires immense capital, and, besides, a combination of coal, salt, and limestone, that can be found close at hand in but few localities. Within a few years another method, known as the ammonia-soda process, has been put into operation in Europe. The first cost of a plant for this process is not large, and since it furnishes a purer product than the Le Blanc method, it will probably supply a considerable portion of the sal-soda of the future, especially in the United States. The newer method has the especial advantage that it forms bicarbonate of soda direct and very pure. Two plants for this process have been erected in America, one of which has been in operation at Syracuse, N.Y., for several years, and the other has recently been erected in Cleveland. As additional illustrations of the possibilities in store for the United States, Prof. Mabery mentioned the manufacture of porcelain, and the production of artificial dyes and colours from coal-tar.

AN interesting report on the pearl fishery of the Gulf of California is contributed by Mr. C. H. Townsend to the new Bulletin of the United States Fish Commission. The season for pearl fishing begins about the first part of May near Cape St. Lucas, whence operations are gradually carried into the Gulf of California, which is usually entered by May 15. During the summer the entire eastern coast of the peninsula is worked, and in October the base of operations is removed from La Paz, the headquarters of the Pearl Shell Company of Lower California, to Acapulco, where the fishery is continued for two or three months longer. Whatever of romance may hitherto have enshrouded the diver for pearls in the sea, he is now, as described by Mr. Townsend, practically a submarine labourer, who uses all the modern diving paraphernalia available. No longer plunging for sixty seconds into the sun-lit green water that covers a coral bank, he puts on a rubber suit with glass-fronted helmet, and, suitably weighted with lead, descends for hours to gather pearl-oysters, which are hoisted in a wire basket by his companions in the boat above, who supply him through a rubber tube with the air he breathes. The best year at the fisheries in comparatively recent times was 1881. During that year many pearls of extraordinary size and great value were obtained; among them was a black one weighing twenty-eight carats, which sold in Paris for 10,000 dollars.

A VALUABLE report on the petroleum trade of the Caucasus has been sent to the Turkish Government by Aassib, the Turkish Consul-General at Tiflis, and some interesting extracts from it are quoted in the *Board of Trade Journal*. The petroleum springs of the peninsula of Apcheron, not far from the place at present occupied by the town of Baku, were known according to the writer, several centuries before the Christian era, and the phenomena produced by them, totally inexplicable in those barbaric ages, gave rise, he says, to the worship of the Guebres, followers of Zoroaster, which lasted into the nineteenth century, for the temple of the worshippers of eternal fire is seen to the present day. The springs of Balakhani are situated 20 kilometres from Baku on a bare and arid plateau, swept by the winds, at an elevation of about 60 metres above the level of the Caspian Sea. The petroleum lands occupy an area of about 8 kilometres. At the present time Balakhani and Sabountchi possess more than 1000 wells, some of them newly bored, producing in twenty-four hours as much as 400,000 pouds. An era was marked in the history of the naphtha industry by the house of M. Nobel, which started at Baku in 1874, and in the following year purchased a small business and undertook the production of petroleum on a small scale. At that time the conveyance of petroleum to Baku was effected by means of carts and leather bottles. M. Nobel endeavoured to show the absurdity of this primitive method of transport, and recommended that pipes should be constructed, but the majority of the merchants rejected the proposal. He then constructed the first pipe at his own cost, and demonstrated the utility of it to his colleagues, several of whom very soon imitated his example, and Baku has to-day a dozen lines of pipes, each of which costs more than 100,000 roubles. The same house, dissatisfied with the system of shipping petroleum in barrels, proposed to the Kavkaz and Mercury Navigation Company of the Caspian and the Volga that they should build tank boats for the exclusive conveyance of petroleum. This proposal having been rejected, the firm constructed several of these vessels at their own expense. This innovation, of which even the Americans had not yet thought, was accepted by the two petroleum-producing countries, and tank boats, the number of which is constantly increasing, are to be found on all the waters of the civilized world. It is also to M. Nobel that those gigantic reservoirs of iron which contain hundreds of thousands of naphtha products are due. They are to be seen in large numbers at Baku, Batoum, and everywhere else where petroleum is carried in bulk. The series of innovations by M. Nobel do not stop there. With a desire to improve land carriage he proposed to the Griazi-Tsaritsine Railway Company the construction of special tank waggons for the transport of the petroleum, guaranteeing a load for them for several years. The railway authorities scoffed at the idea, and it was by the expenditure of very large sums that the Swedish merchant constructed for his own use the first tank waggons. Scorn was immediately changed to enthusiasm, and to-day thousands of these waggons circulate on the railways of Caucasia and Griazi Tsaritsine.

IN Part xxi. of the Zoological Reports of the Norwegian North Atlantic Expedition, Christiania, 1892, Dr. D. C. Danielssen gives an account of the Crinoids and Echinoids of the North Atlantic. Chief among the former is the beautiful *Bathycrimus carpenteri*, first described as *Ilycrinus carpenteri* by Koren and Danielssen in 1877 from specimens collected by the expedition, and thought to be a new genus, but a careful study and comparison with Herbert Carpenter's description in the report of the *Challenger* Crinoids proved it to belong to *Bathycrinus*. The morphology of this species is very fully described and figured; very interesting are the statements about the apparent formation of "new crown" on specimens which had apparently lost their first crowns; in one of these "the stalk was 110 mm. in height, the crown was 2·5 mm. high, and the root was 20 mm. in length. The radials of the crown were attached to the basals by a pretty broad seam, the basals being concreted and forming a firm ring as upon old individuals; which distinctly showed that while the radials were a new formation, the basals pertained to the old detached crown and formed the true calyx from which the new crown issued." In this specimen the tentacles could not be seen, and it was very difficult to observe the disc, as it was covered by the closed arms which could not without damage be separated from each other, but that a new crown was in course of formation seemed indubitable. In addition to this species of Bathycrinus, *Rhizocrinus lofotensis*, and the following species of Antedon were found:—*A. tenella*, Retzius; *A. petasus*, D. and K.; *A. prolixa*, Dun. and Sladen; *A. quadrata*, Carp.; and *A. eschrichti*, Muller. Fourteen species of Echinida are mentioned, of which *Echinus alexandri*, Dan. and Kor., is redescribed and figured.

THE additions to the Zoological Society's Gardens during the past week include a Hainan Gibbon (*Hylobates hainanus*) from Southern China, presented by Mr. Julius Newman; a Humboldt's Lagothrix (*Lagothrix humboldti*) from the Upper Amazons, presented by Mr. Chas. Clifton Decconson, F.Z.S.; a Red Howler (*Mycetes seniculus*) from New Granada, presented by Mr. John F. Chittenden, C.M.Z.S.; a Garnett's Galago (*Galago garnetti*) from East Africa, presented by Commander H. J. Keene, R.N.; a Bennett's Wallaby (*Halmaturus bennettii* ♂) from Tasmania, presented by Lieutenant E. A. Findlay, R.N.R.; a Raccoon (*Procyon lotor*) from North America, presented by Mr. A. C. Cooke; a Short-toed Eagle (*Circaetus gallicus*) from Southern Europe, presented by Mr. B. Vincent; a Leadbeater's Cockatoo (*Cacatua leadbeateri*), a Slender-billed Cockatoo (*Licmetis tenuirostris*) from Australia, presented by Mrs. Phillips; a Rock Thrush (*Monticola saxatilis*), two Solitary Thrushes (*Monticola cyanus*), European; a Common Jay

(*Garrulus glandarius*), an Ortolan Bunting (*Emberiza hortulana*), a Blackbird (*Turdus merula*), a Nightingale (*Daulias luscinia*), British, presented by Mr. E. Cossavella; a Common Jay (*Garrulus glandarius*), a Natterjack Toad (*Bufo calamita*), six Crested Newts (*Molge cristata*), three Palmated Newts (*Molge palmata*), British; three Sand Lizards (*Lacerta agilis*), five Yellow-bellied Toads (*Bombinator bombinus*), an Edible Frog (*Rana esculenta*), European, presented by Mr. G. B. Coleman; four Common Snakes (*Tropidonotus natrix*), British, presented by Count Pavoleri, F.Z.S.; a Malbrouck Monkey (*Cercopithecus cynosurus*) from West Africa, a Barbary Wild Sheep (*Ovis tragelaphus ♂*) from North Africa, two Common Squirrels (*Sciurus vulgaris*), British, deposited; two black Apes (*Cynopithecus niger*) from Celebes, purchased.

OUR ASTRONOMICAL COLUMN.

Solar Observations at the R. Osservatorio del Collegio Romano.—Prof. Tacchini, in the *Memorie della Società degli Spettroscopisti Italiani*, gives a tabular statement of the prominences, faculæ, and spots visible on the sun's surface during the first three months of the present year. Taking the case of the number of prominences, no less than 300 were observed during this period, 161 appearng in northern and 139 in southern latitudes. During the first two months prominences were more numerable in the south hemisphere, amounting to an excess of 7 and 5 respectively, but in March as many as 78 were recorded for the northern as against 44 for the southern. The latitudes for the regions of greatest frequency were + 40° + 30° and − 20° − 30°.

For the faculæ 28, 24, and 18 (total 70) were recorded for the northern latitudes, while very nearly the same number (76 = 20 + 18 + 38) was observed on the southern hemisphere. In both cases the record for latitudes ± 50° ± 40° was one, the greatest number appearing in latitudes ± 10° ± 30°.

The total number of groups of spots recorded was 80, of which 38 were observed north of the equator. Curiously enough the month of February only contributed 21 out of this number, 34 being recorded for January; the region of greatest frequency occupied the zones ± 10° ± 30°.

Allowing for the very unfavourable season for observations, a considerable increase over the preceding quarter will be at once noticed. The relative amount of spotted area shows an enormous increase for February, the numbers for the months commencing with January being 79.79, 153.61, and 61.57.

A Remarkable Prominence.—Mr. J. Fényi, in the *Memorie della Società degli Spettroscopisti Italiani*, gives an account of an unusually large prominence that was visible at Kalocsa, on May 5 last. At 10h. 25m., Kalocsa mean time, the prominence was very small, but later it developed very considerably, forming itself into a set of small bands, clearly inclined towards the equator. At 11h. 55m. the observed height was 139″, there being no indication of a rapid ascent. At 12h. 11m. a very rapid upward motion had already begun to make itself visible, and by 12h. 17m. 34s. the height reached was 287″, extending to 317″ 1m. 11s. later, when the velocity of ascent was 306 km. per second. After a few minutes the lower parts to the height of 360″ became invisible, but the smooth portions ascended at 12h. 21m. 4s., with a velocity of 368 km. per second to a height of 531″. This latter measurement was made at 12h. 29m. 25s., and soon after the object was no more seen. The actual height attained, then, may be reckoned about 381,800 km., or 237,126 miles. At the terminaton of this eruption, it was noticed that the prominences at 127° and 79°, and even the one at 106°, which very nearly coincided with the position of the eruption itself, still retained the same forms, having apparently suffered no change by this enormous disturbance; no faculæ or spots either were recorded which could in any way be connected with this outbreak.

The Trapezium in the Orion Nebula.—During the first three months of the present and preceding year Dr. L. Ambronn, of the Göttingen Observatory, has undertaken a measurement of the distances and position angles between the four bright stars forming the trapezium in the great nebula of Orion. The results which he has obtained are recorded in the 3103 number of *Astronomische Nachrichten*.

Commencing with the star θ′ Orionis, which is here designated *a*, and taking the others in cyclic order following the direction opposite to that of the motion of the hands of a watch, we find these designated by *b*, *d*, and *c* respectively. The accompanying table, for the sake of comparison, shows the position angles and distances for the equinox 1870 from the measurements of W. Struve, Dembowski, O. Struve, Hall, and Ambronn.

	W. Struve. 1836·15	Dembowski. 1867·04.	O. Struve. 1870·0.	Hall. 1877·7.	Ambronn. 1891 6.
	° ′	° ′	° ′	° ′	° ′
ab	311 45	311 22	311 32	311 4	311 15
ac	60 29	61 38	60 22	61 8	60 58
ad	340 20	342 23	342 5	342 15	342 31
bc	95 35	96 2	95 36	95 34	95 26
bd	31 48	32 11	31 43	32 55	33 1
cd	299 34	299 33	299 34	299 18	299 15
	″	″	″	″	″
ab	13·002	12·907	13·049	13·116	13·250
ac	13·344	13·385	13·276	13·453	13·698
ad	16·854	16·681	16·876	16·768	16·997
bc	21·414	21·582	21·410	21·758	22·038
bd	8·706	8·706	8·705	8·772	8·915
cd	19·227	19·340	19·237	19·363	19·576

New Variable Stars.—A short note communicated by Prof. Pickering to *Astronomische Nachrichten*, No. 3104, informs us that six new variable stars in the southern sky have been discovered on examination of the photographs of stellar spectra taken at Arequipa in Peru. The following are the constellations, positions, and the dates on which the photographs were taken:—

Constell.	α 1900 h. m.	δ 1900 ° ′	Date.
Horologium ...	... 2 49·5 ...	− 50 10 ...	Sept. 10, 1891
Octans ...	... 6 0 ...	− 86 30 ...	Sept. 11, 1891
Bootes ...	... 14 22·1 ...	+ 5 2 ...	April 26, 1892
Octans ...	... 17 30 ...	− 86 45 ...	Aug. 31, 1891
Sagittarius	... 19 49·8 ...	− 29 27 ...	Oct. 3, 1891
Tucana ...	... 23 53·2 ...	− 65 56 ..	Aug. 25, 1891

All these stars when at a maximum are as bright or brighter than the 8th magnitude, but only one, that in Sagittarius, is a catalogue star (Cord. G.C. 27271, Mag. 8½).

THE BRITISH ASSOCIATION COMMITTEE ON ELECTRICAL STANDARDS.

In view of the hoped-for presence of Prof. von Helmholtz and other distinguished foreigners at this year's meeting of the British Association in Edinburgh, it will probably be recognized as suitable to take up and continue the discussion on new electromagnetic units for practical purposes, which was begun last year at Cardiff.

I therefore beg to contribute the following notes and to conclude by moving some resolutions.

One great fact brought into prominence by the practical development of electricity is the analogy or reciprocity between the electric and the magnetic circuit, and this is the fact which it behoves us to emphasize in the naming of fresh units.

The magnetic circuit has as yet no authorized names applied to it. The electric circuit is well provided, but perhaps one or two improvements can be made.

(1) The Electric Circuit.

The first point on which I consider that practical men would do well to insist is that names shall be given to the complete things dealt with, rather than to mere coefficients. Thus of all units with which they are concerned there can be no doubt but that *volt* and *ampere* are the most prominent. These are the active things with which Electrical Engineers have to deal, and these are the things for which meters exist on every wall in an electric lighting station. The ohm, or unit coefficient of resistance, is comparatively academic in character; it is a constant of a coil of wire or of an underground lead, it is nothing vivid and active. The engineering use of the term ohm is mainly in connection with insulation and other high resistances; for large conductors the equivalent "volt per ampere" is perhaps more often used. It is the drop of potential which a given conductor entails for a given current that is of real interest to an engineer, and it is this of which in large leads he consciously thinks.

A 6 ohm conductor means one that drops 6 volts for every ampere that is sent along it. If you send 3 amperes along such a line, the potential at the far end is 18 volts below that at the near end. The clear realization of this fact would be almost aided by the complete title, 6 volts per ampere, instead of the abbreviation, 6 ohms. Nevertheless, the name ohm is in common use and hence may be assumed useful.

A still more useful name, however, for good conductors would really be the reciprocal of an ohm—the ampere per volt. Suppose this called a mo, as Sir W. Thomson once suggested, then a cable of 20 mos would be one that conveyed 20 amperes with a drop of 1 volt. A thousand-mo cable would convey 500 amperes with a drop of half a volt, and so on. It is more directly practical to think of the amperes conveyed per drop of voltage, than of the drop of voltage per ampere. I believe that some authorized name for unit conductance would be welcomed.

Units of Inconvenient Size.

The authorized name "coulomb" for unit quantity is barely used by engineers, who are content with ampere-hour; thus proving that what is needed in practical units is not so much a consistent decimal system, as a set of units each of practicable magnitude.

Farad.

The effort after consistency has resulted in the useless "Farad"; and this should be a lesson not to try and fix units of unreasonable size. The c.g.s. units already exist as a consistent system; the only objection to them is that they are of unpractical size. The whole object of devising a practical system of units was to have things of every-day size to deal with. The volt, the ampere, and the ohm satisfy this condition. The coulomb, the farad, and the watt do not. Already they have practically given place to the ampere-hour, the micro-farad, and the kilowatt.

Considerably more progress would have been made in knowledge of ordinary capacities if the microfarad had been called the farad, so that easy submultiples of it would have been available to express the capacity of Leyden jars, and such like things. The capacity of an ordinary jar would then have been a few millifarads, and a microfarad would have been the capacity of a short bit of connecting wire. I ask whether this change would introduce serious confusion even now. I think not. Nobody cares the least about "coulombs per volt," and so there is no sense or use in the present farad. Telegraphists would surely soon consent to drop the useless prefix micro; and the factor of a million is too great to render doubt possible as to what was intended, even in the transition stage. It ought to be regarded as essential to have the practical unit somewhere not hopelessly away from the middle of the range of probable multiples and submultiples.

Coulomb.

A coulomb again is almost useless as a synonym for the ampere-second; it is so easy to speak of ampere-minutes or ampere-hours. If the name coulomb could be set free from its present superfluous meaning it could usefully be applied to the electrostatic unit of quantity, which wants a name. Teachers would find it convenient at once, and in the apparently imminent line of development engineers might find it useful before long. It is the charge on a two-centimetre sphere at a potential 300 volts (or on a one-foot sphere at 20 volts). The capacity of the two-centimetre sphere would be $\frac{9}{10}$ of a (new) microfarad.

Watt.

Lastly with regard to the watt. The name volt-ampere is almost as good as the name watt, especially since the watt is also one joule per second.

Both names, watt and joule, are not really wanted by electricians, to whom their coexistence is rather confusing. I believe it would be more convenient to use the term watt in the sense it gets so frequently used now, viz., energy, say a volt-ampere-hour; in which case a kilowatt would be synonymous with the present Board of Trade unit.

The rate of working, or power, could then be expressed in a rational and unforced way as so many watts per hour or so many volt-amperes. It is much more natural to give a name to a definite thing like a quantity of energy, than it is to give it to a mere rate of working. The latter is instinctively felt to need a reference to time; just as a velocity unit has not been practically found to need a name, being quite simply expressible in feet per second or miles per hour; and even when a name has been given, like "knot," instinct constrains people to practically get rid of it again by speaking of knots per hour, just as we find "kilowatts per hour" already often used in electrical workshops. I suggest, therefore, that the present watt is too small, that it is sufficiently expressed by a joule per second, and that it would be more useful if magnified 3,600 times, and turned into a unit of energy.

That we should thus have several energy units—the erg, the joule, and the watt, all of quite different sizes, is no objection, but an advantage, seeing the extreme importance of energy. Such things as length, mass, time, and energy demand a fair range of units. It would be tedious to express centuries in seconds.

(2) MAGNETIC CIRCUIT.

In speaking of the magnetic circuit I wish to refer back to my opening remarks concerning the electric circuit, and the class of things for which names should be found. In the magnetic circuit the only thing at present seriously attempted to be named is, in accordance with the historic parallel of the ohm, a coefficient or characteristic of a coil of wire—its coefficient of self-induction; the unit of which has been called variously a secohm, a quadrant, and a henry.

Total Induction.

But the real active thing with which engineers are concerned is total magnetic induction, total number of lines of force across an airgap: as between the polepieces or through the armature of a dynamo, or in the circuit of a transformer. It may be called the electromagnetic momentum per turn of wire; or the surface integral of B. This total induction is in some respects analogous to electric current, and has occasionally been called magnetic current (a bad name), or "magnetic flux." It is, however, more strictly analogous to the coulomb, and its time rate of variation is the more proper representative of electric current.

Its common practical name at present is "total lines," or "total induction," or "number of lines."

Now "one line" is awkward as a unit, besides being (if a c.g.s. line) inconveniently small. The earth, for instance, sends 4,400 such lines through every horizontal square metre about England; through a square inch it only sends a fraction of a line. A practically sized unit of induction badly wants a name, and "henry" would have done for it very well, and have been both more suitable and more useful for the actual quantity than for a coefficient. But "henry" has already been half appropriated to the secohm, so, for illustrative purposes at any rate, I propose to use the name "weber" for the unit magnetic flux.

Concerning the most convenient size for the weber, there is much to be said for making it 10^8 c.g.s. lines, though that is bigger than ordinarily occurs in practice; because then a wire which cuts one weber per second will have a volt difference of potential between its ends. Or a coil of twenty turns through which the magnetic induction changes at the rate of one weber per second will have an E.M.F. of twenty volts induced in it. The average E.M.F. in such a coil, spinning thirty turns a second, and enclosing a maximum total-induction of one weber, is 600 volts.

This is the dynamo use of the unit; the following is the motor use.

A wire carrying an ampere and cutting a weber per second, does work at unit rate, viz., one joule per second.

Probably the simplicity of all this compensates for the rather unwieldy size of the unit. A strongly magnetized piece of iron may have 20,000 lines to the square centimetre; so a weber could occur across a narrow airgap half a square metre in area.

The earth gives an induction of about one weber through every 23,000 square metres of England, or 100 webers per square mile. The earth induction through a horizontal square metre is 44 micro-webers, so with micro- and milli-webers the range would be fairly covered; though a smaller weber would have been better if it had been equally convenient as regards the volt.

The pull between two parallel surfaces joined by a weber is $\frac{10^{16}}{8\pi}$ dynes, or four hundred thousand tons. A milli-weber gives less than half a ton pull; and a micro-weber less than half a gramme.

Because of the property that the voltage excited in a circuit is equal to the webers cut by it per second, a weber might be called a sec-volt. It is equal to a secohm-ampere-turn; that is to say, if a single turn of wire can have a self-induction coefficient of one secohm, it will excite a weber of induction for every ampere passing through it.

[Such a circuit in the form of an anchor ring would be enormous, something like a mile across; but it could be made in the form of a solid cylinder of best iron ($\mu = 2500$), with an axial perforation for the wire, and 80 metres long.

If a secohm coil has n turns, then an ampere passing through it excites only $\frac{1}{n}$th of a weber; for, since every turn encloses the induction, the latter is effective n times over, and so the induction coefficient is n times the induction per ampere, or n^2 times the induction per ampere turn.]

No name is needed for intensity (or density) of induction (B), for that can always be expressed in webers per unit area.

[For instance, strongly magnetized iron, with say 10,000 lines to the square centimetre, has one-tenth of a weber per square foot, or 0·7 milli-webers per square inch.]

And there is a practical gain in thus leaving the specification of area open, for it enables British units of length to be employed in measuring air-gaps, yokes, cores, and polepieces.

So long as dynamo dimensions are commonly expressed in inches, there is no serious objection to specifying induction in fractions of a weber per square inch or per square foot.

Magnetomotive Force.

Now consider the magnetic analogue of the volt; the unit of magnetic potential or magnetomotive force. By this is understood the line integral of the magnetizing force H, the quantity $4\pi n\mathrm{C}$, the step of potential once through and all round the circuit of a coil. It is a quantity most important in practice, and requires a name.

Mr. Heaviside has suggested the name "gaussage," as analogous to voltage; and, if this were adopted, the unit of magnetomotive force would be the gauss. The intensity of magnetizing force would be the gauss-gradient, or drop of gaussage per centimetre; no special name is needed for the unit of this quantity H.

The common practical unit of gaussage at present is the ampere-turn, and this has several advantages. It may, however, be found better to make some convenient number of ampere-turns into a gauss; for instance, the c.g.s. unit of gaussage would be $\frac{4\pi}{10}$ or 1·2566 ampere-turns. If that were adopted as the gauss, the horizontal component of the earth's magnetic intensity about here would be, say ·18 gauss per linear centimetre.

But this unit, whether the c.g.s. unit or the ampere-turn, is very small. The step of potential all round a single ampere-turn is only equivalent to a vertical step of about 2 centimetres in the earth's field.

Nevertheless, in spite of its smallness, the ampere-turn as practical unit of gaussage will probably commend itself by reason of its simplicity. Let us see how it works out.

Reluctance.

The ratio of gaussage to the induction excited by it, is a quantity characteristic of the magnetic circuit, and called its reluctance or magnetic resistance. This is the quantity $\frac{l}{\mathrm{A}\mu}$ for simple circuits, or $\Sigma\frac{l}{\mathrm{A}\mu}$ for complex ones; it is unfortunately not constant for any but air circuits. This constitutes one difficulty of naming its unit satisfactorily, else it might be expressed as so many "gilberts" or "sturgeons" (analogous to ohms). It is, however, fairly constant under many common conditions of practice, and it can always be expressed as gausses per weber; and perhaps this way is sufficient.

A magnetic circuit with unit reluctance is one that requires one gauss to induce in it one weber.

Permeability.

Permeability (μ), analogous to electric conductivity, would be measured by the webers induced through unit cube of the material between whose faces there is unit fall of gaussage. It has been suggested (by Prof. Perry) that the permeability of air had better be called $4\pi \times 10^{-9}$. But the whole electromagnetic system of units is based on the μ for air being called 1; so it would be rather confusing to change that. Moreover, it would be a retrograde step to affix another incorrect value to the constant μ, instead of waiting and trying to find out what its value really is. It is better to adhere for the present to the existing table of permeabilities, and to use whatever constant factor may be needed in order to turn $\frac{l}{\mu\mathrm{A}}$ into practical units of reluctance.

Permeance.

But the reciprocal of reluctance, or the webers induced per gauss, may be the more instructive thing to attend to and name; just as conductivity is often more directly interesting than resistance. This reciprocal ratio, $\frac{\mu\mathrm{A}}{l}$, has been called "permeance," and that is not a bad name for it; it is proportional to the inductance of a single-looped circuit. Permeability is the permeance of unit cube of the material. Permeance is the webers induced per unit drop of gaussage. Permeability is the webers per unit area induced by unit gauss gradient.

The permeance of the magnetic circuit enclosed by a solenoid of wire is the same as its appropriate self-induction-coefficient divided by 4π times the square of its number of turns.

The c.g.s. unit of permeance (or of reluctance) is that of a centimetre cube of air, and is not a bad-sized unit. But it is inconsistent with the weber as 10^8 and the gauss as a single ampere turn.

One of the three must give way.

On the whole I have no hesitation in suggesting that the derived unit (that of permeance) must give way, and be taken as $4\pi \times 10^7$ c.g.s. units, in order to harmonize with the other two as already defined.

The fact is that the great size of the weber renders a small gauss desirable, in order that their product may not represent too large a quantity of energy. For instance, if 1 c.g.s. unit were taken as the unit of permeance, the weber being fixed at 10^8, then the gauss would also be 10^8, and the gauss-weber would be 10^9 joules, or nearly 300 Board of Trade units; which is far too much.

Whereas if the unit of permeance is fixed high, and the gauss kept small, then the energy corresponding to a gauss-weber may be moderate. Thus with 10^8 c.g.s. as weber, and an ampere-turn as gauss, their product is only $\frac{10^9}{4\pi}$ ergs, or $\frac{100}{4\pi}$ or about 8 joules; which will be useful in energy considerations connected with the heating of transformers.

I therefore propose, in order to retain the ampere-turn as unit of gaussage, that the permeance of a cylinder of material of length l and area A be reckoned as $\frac{\mu\mathrm{A}}{l}$ multiplied by $4\pi \times 10^7$, if dimensions of the cylinder are measured in centimetres; μ being its ordinarily tabulated value with air = 1. If dimensions are measured in inches, then the permeance of a cylinder will be $\frac{\mu\mathrm{A}}{l}$ multiplied by $\frac{4\pi}{2{\cdot}54} \times 10^7$, that is by about $\frac{1}{2}$ 10^8.

The unit of permeance thus suggested is immensely big, and it requires a name of which easy sub-multiples could be formed.

A slab of iron 1 centimetre thick, and with its $\mu = 2500$, would need an area of 5 square metres in order to have unit permeance; but a micro-unit would be possessed by an air-gap a millimetre thick and less than a decimetre square.

PROPOSED RESOLUTIONS.

(1) That the unnecessary prefix "micro" be dropped before the word farad, and that the farad be defined afresh as 10^{-15} c.g.s. electromagnetic units of capacity.

(2) That the name "mo" for the unit of conductance or the ampere per volt, be recognized and adopted. (Every *mo* in a cable enables it to carry an ampere with a drop of 1 volt.)

(3) That the ampere-hour be recognized as a convenient practical unit of electrical quantity.

(4) That the volt-ampere-hour be recognized as a convenient

practical unit of electrical energy, and be called the watt. (It equals 2640 foot-pounds, or a trifle over a foot-ton.)

(5) That the present Board of Trade unit be called a kilowatt.

(6) That the ordinary unit of power be a kilowatt per hour [It equals about 4/3rds of a horse-power, more accurately $\frac{1000}{746}$ HP.]

(7) That it is convenient to retain the name joule in its present sense of a volt-coulomb, or ten million ergs, for use in the science of heat; since heat-capacities are conveniently expressed in joules per degree; and it will be handy to remember that a volt-ampere generates one joule of heat per second.

(8) That the name coulomb be affixed to the electrostatic unit of quantity [for academic purposes].

(9) That a name be given to unit magnetic flux or total induction, and that the name weber is suitable.

(10) That the most convenient size for the weber is 10^8 c.g.s. units or "lines" (since the rate of change of this through a circuit is equal to the induced voltage).

(11) That a name be given to unit magnetic potential or magnetomotive force, and that the name gauss is suitable.

(12) That the handiest size for the gauss is one ampere-turn.

(13) That a name be given to the ratio of the weber to the gauss, or unit of permeance, or self-induction per turn of wire. [If the above resolutions were adopted, this unit would be $4\pi \times 10^7$ c.g.s. units, or $\frac{1}{8}$ secohm per turn.]

(14) That intensities of field be expressed in gausses per unit length, and densities of induction in webers per unit area (leaving the length or area unit open for practical convenience to arrange).

No doubt many of these recommendations have been made before. Mr. Preece has often urged the change of farad, so that I hope there will be no difficulty about that.

I find that my magnetic suggestions are very similar to those suggested by Prof. Perry in his modified letter to the Committee as published in the *Electrician*, vol. xxvii. p. 355 [July 31, 1891], and received there with approving editorial comments. The accordance between our suggestions is satisfactory, and makes it likely that they are such as engineers may be satisfied with and be willing to adopt. I need hardly say that I lay no stress upon the particular *names* here proposed. In choosing them I have been influenced by such trivial considerations as the selection of a monosyllable to correspond with volt, and a dissyllable to correspond with ampere or coulomb.

[With regard to Prof. Perry's footnote concerning college instruction and use of c.g.s. units, I suppose systems of teaching differ, but a senior student *ought* to be taught to deal with concrete quantities in so familiar a manner that no possible admixture of units can be any puzzle to him, nor involve anything worse than a little tiresome arithmetic.]

MECHANICAL UNITS.

There are several quantities in dynamics beside the joule and the watt for which brief names would be advantageous. I do not propose to discuss these fully now, but the present opportunity might be utilized by agreeing to at least one unit, that of pressure, viz., the "atmosphere"; which might be defined as 10^6 c.g.s., or dynes per square centimetre, and stated to be equal to the pressure of a column of mercury 75 centimetres high at a specified temperature. The inconvenient pressure, 76 centims., might be spoken of as a Regnault atmosphere. I believe that a smaller unit of pressure, for instance, the micro-atmosphere or "barad," might also be usefully named. These pressure units will be useful for expressing energies per unit volume also, and the "barad," or whatever other name is decided on for the erg per cubic centimetre, is of reasonable magnitude for many purposes.

OLIVER J. LODGE.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE annual summer meeting of the Institution of Mechanical Engineers, held last week at Portsmouth, was a successful gathering in regard to numbers present and the attendance at the excursions; but the business part of the meeting, which consists of the sittings at which papers are read, was of a rather tame character. The following is a list of the papers on the agenda:—

On Shipbuilding in Portsmouth Dockyard, by Mr. William H. White, C.B., F.R.S., Director of Naval Construction and Assistant Controller of the Navy.

On the Applications of Electricity in the Royal Dockyards and Navy, by Mr. Henry E. Deadman, Chief Constructor, Portsmouth.

Description of the Lifting and Hauling Appliances in Portsmouth Dockyard, by Mr. John T. Corner, R.N., Chief Engineer, Portsmouth.

Description of the New Royal Pier at Southampton, by James Lemon, J.P., Mayor of Southampton.

Description of the Portsmouth Sewage Outfall Works, by Sir Frederick Bramwell, Bart., D.C.L., LL.D., F.R.S., Past-President.

Description of the New Floating Bridge between Portsmouth and Gosport, by Mr. H. Graham Harris, of London.

Description of the Southampton Sewage Precipitation Works and Refuse Destructor, by Mr. William B. G. Bennett, Borough Engineer and Surveyor.

Description of the Experimental Apparatus and Shaping Machine for Ship Models at the Admiralty Experiment Works, Haslar, by Mr. R. Edmund Froude, of Haslar.

Description of the Pumping Engines and Water Softening Machinery at the Southampton Water Works, by Mr. William Matthews, Waterworks Engineer.

Mr. Matthews' paper was adjourned, and that by Mr. Froude was not read, as time ran short. This was much to be regretted, as the Haslar experimental works are one of the most interesting of all our establishments set apart for scientific investigation. It is to be hoped, now Mr. Froude has broken the ice, that he will contribute a fairly complete descriptive paper to the Institution of Naval Architects, where he would naturally find a more appreciative audience than amongst the members of a society devoted more exclusively to mechanical engineering. Although there was not time for the reading of the paper, Mr. Froude very good-naturedly stopped and explained to some of those present the working of the apparatus which he had brought for the purpose of exhibition, together with the large wall diagrams that had been prepared expressly for illustrating the paper.

On the members assembling in the Town Hall on July 26, Dr. Anderson, the President, occupied the chair, and the usual formal business having been disposed of, Mr. White's paper was read. This was chiefly of a historical character, the author going back to the year 1212, when the sheriff of the county of Southampton was ordered to enclose the King's Dock by a strong wall, and to provide suitable storehouses. A dockyard, properly so called, was not, however, founded until the reign of Henry VIII., so it was second in point of antiquity to Woolwich Dockyard. The latter was closed in 1869, "so that Portsmouth Yard is now," Mr. White says, "the oldest as well as the most important in existence." We do not know whether Mr. White means by this that it is the oldest in existence in Great Britain, or in the whole world. In 1540 the total area was 8 acres. Until nearly the end of last century there was no basin in which ships could lie while completing or repairing, and the dock accommodation was poor, but about that time a basin of 2½ acres and six dry docks were constructed. At that time the yard area was 90 acres. In 1843-50 a steam factory was added, and another basin of 7 acres, besides four docks; the total area of the dockyard being 115 acres. The effect of steam on the navy is well illustrated by the extensions that took place about 1864, when the area of the Dockyard was more than doubled. A fitting-out basin of 14 acres, a rigging basin of the same size, and a repairing basin of 22 acres, were made. There is also a tidal basin of 10 acres. The extent of Portsmouth Dockyard is now nearly 300 acres.

Mr. Deadman's paper was also largely of an historical nature, giving many interesting details of the introduction of electricity into the navy. Among the most notable features in the application of electricity to naval purposes are the temporary installations used for interior lighting during the building and finishing of the vessel. The estimated cost of electric lighting during the period of building the *Royal Arthur* was £1200. This would be about the same sum as would be required were candles used, but naturally electricity affords a far superior light, and it is to its use that is due much of the quickness with which the

Royal Sovereign was finished. There was nothing very startling in Mr. Deadman's paper, which was none the less a useful record of facts. During the discussion, however, Mr. Crompton sounded a very stirring note. He roundly told the whole body of important dockyard officials and Admiralty officers present, including even the Director of Naval Construction, that they were altogether behind the age in the matter of electricity, that the French and German navies were far ahead of them, to say nothing of other powers, and that generally the English Government was the most benighted and non-progressive Government in all the world, so far as the matter of electricity was concerned; for they paid twice as much as they ought to do for an article that was not half as good as it should be. That was the purport of Mr. Crompton's speech, if not the exact words he used, and one cannot but acknowledge that he did not speak altogether without a text. It is hard to fully account for the want of enterprise in the Royal Navy, but there is one point to which we might draw attention. The paper read at the meeting was by a naval constructor, and electricity is, we understand, within the Constructor's department. Now electrical engineering is essentially an engineering question, and its consideration requires engineering knowledge and ability of a very high order. In the early days nothing kept electric lighting back more than the bad engineering that was associated with it; and thus it will always be so long as engineers are not employed in carrying out the plans which are founded on the researches of those more highly scientific investigators, upon whose experiments and deductions the practical applications are founded.

The next paper read was Mr. Corner's contribution, in which he described the lighting and hauling apparatus used at Portsmouth. These may be divided into the hydraulic installation, the compressed-air appliances, and the ordinary steam cranes. There are in the dockyard ninety-six boilers, which burn about 10,000 tons of coal per annum, but what proportion of this is used for lifting and hauling we do not know. In the hydraulic department there are nearly two miles of pressure pipes varying from 1½″ to 4″ in diameter. There are also some independent installations, as well as the coaling arrangements for the fleet at coaling point. There are here ten 30 cwt. cranes, and three 10 ton tips, with necessary capstan weigh-bridges. The more modern lifting and hauling appliances are by compressed air, the air being compressed to 60 lbs. With this pressure there is little or no trouble with frost, only a little forming at the exhaust in very damp weather, and altogether the pneumatic system seems to be preferred to the hydraulic. It must be remembered that the power required is variable, and this of course brings the advantage of the pneumatic system, in the matter of working expansively, to the fore. We understood Mr. Corner to say, during the discussion, that when the hydraulic motors and the air-engines were both worked at their full power the water system was the most economical, but working linked up, under the prevailing conditions, the air system was the best. The condensation of steam in the pipes is the objection to the steam motor when situated at some distance from the boiler, otherwise steam would be the best vehicle. The other papers read do not call for any special notice at our hands, their titles giving a sufficient indication of their scope, and there being no features of especial novelty in the matters they described.

A number of excursions had been arranged, and were carried out in a very satisfactory manner. On the first day, Tuesday, the 26th ult., the members visited the Dockyard, and were welcomed by the Admiral Superintendent in person. On Wednesday the Portsmouth Sewage Works were visited, and a trip was made to the Clarence Victualling Yard at Gosport. On Thursday a trip was made to Southampton, where the Docks were inspected, and a visit was paid to the Union Steamship Company's new engineering shops. There was an alternative visit to the Ordnance Survey Office. In the afternoon a visit was paid to the London and South Western Railway Company's new carriage and wagon shops at Eastleigh. Friday was devoted wholly to frivolity, the only item on the programme being a steamer trip round the Isle of Wight. On Saturday a good many of the members went to Brighton to visit the locomotive works of the London, Brighton and South Coast Railway. Largely owing to the exceptionally fine weather the meeting was a great success, and, for pleasantness, may rank with the Dublin meeting of three or four years back.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The fifth summer meeting of Oxford University students commenced on July 29, and will continue till August 27. The general outline of the programme has already been noticed in these columns, but we may notice here that the popularity which has attended these gatherings shows no signs of diminishing. It was announced by the Provost of Queen's College, who presided at the inaugural lecture given by Mr. John Addington Symonds, that upwards of 1250 students had come to attend the lectures it was proposed to deliver. In welcoming the students to the meeting, Dr. Magrath remarked that last winter 60,000 students (including 10,000 artisans) regularly attended the extension lectures of the various universities engaged in the work. There had been 312 courses of Oxford lectures. He also commended the co-operative societies of the North, and particularly the Co-operative Union, and mentioned the individual liberality of Mr. Dixon Galpin, who had founded scholarships for students from Dorset to attend this summer meeting. The munificence of Mr. Galpin had been supplemented by the Dorset County Council. A University Extension College had been recently established at Reading, under the presidency of Mr. MacKinder, an example which he hoped would be followed at other centres.

On Monday a conference was held in the Union Debating-room, under the presidency of Mr. J. G. Talbot, M.P., to consider the relations between the County Councils and the University extension movement. The president invited the lecturers under various County Councils to express their opinion as to the advantages, prospects, and difficulties which they had met or encountered in the course of their peripatetic teaching. His own opinion was that one very successful result of these lectures would be the amalgamation of the classes and the masses, and he noticed that one of the candidates to whom a County Council had awarded a scholarship was in the position of an agricultural labourer.

Mr. Hall, who had been a University Lecturer under the Surrey County Council, cautioned the meeting against entertaining any exaggerated views of the actual information that he had been able to convey to the agricultural labourers. He himself was satisfied if he could awaken a desire for knowledge in the rural mind and convince the extremely conservative agriculturist that he had something to learn.

Mr. Sells, of the Yorkshire College, Leeds, described the activity of that portion of the Victoria University, and believed that in the North they were in advance of the Oxford movement in meeting the actual and practical wants of the labouring section of the community. Coal-mining was taken up by them with eagerness, and the agricultural lecturers carried about with them the actual implements of husbandry in order to bring the matter practically before their audience. The discussion was continued by Mr. Sadler, secretary to the Delegacy, who said that alliances had been entered into with twelve large counties in the past year, and they should be proud of the achievement. In his opinion they ought to give a stimulus to learning to the masses, and for this reason they ought also to combine with the elementary teachers. Help should also be given to individuals, and it was necessary to secure the services of good men, by enabling the scheme to compete with other professions in the matter of the remuneration offered.

Mr. MacKinder (University Extension Lecturer) and Dr. Magrath agreed in deprecating any fixed cut and dried plan for the whole country, but thought that the scheme should be varied to meet the different circumstances of the various County Councils. At the same time, each County Council should have a definite policy.

SCIENTIFIC SERIALS.

THE *Quarterly Journal of Microscopical Science* for March 1892, contains:—On a new branchiate Oligochæte (*Branchiura sowerbyi*), by Frank E. Beddard, M.A. (plate xix.). This annelid, found in mud from the "*Victoria regia* tank" in the Royal Botanical Gardens, Regent's Park, London, is remarkable for the unusual contractility of its body, which suggested a leech or flat worm rather than a Chætopod. It consists of about 120 segments. When magnified the orange-coloured digestive tract traversed by the bright blood vessels is seen, and at the posterior end of the body there is a series of delicate dorsal and ventral processes; these latter are segmentally arranged, developed in pairs upon the last sixty segments or so of the body. There is no connection between the setæ and these processes, as in Bourne's Chætobranchus, also found in the same tank. This worm is referred to the Tubificidæ, without having any certain affinities to any of the known genera.—On the formation of the germ-layers in *Crangon vulgaris*, by W. F. R. Weldon, M.A. (plates xx. to xxii.). The author's conception of the early development differs widely from that of Kingsley. —On the pigment cells of the retina, by I. S. Boden and F. C. Sprawson. The retinal pigment cells are not, as usually represented, invariably hexagonal; in specimens taken from the eyes of sheep, ox, rabbit, kitten, pig, hen, and frog, while hexagonal cells were the most numerous, heptagonal cells were frequently found and scattered at intervals. Cells with four, five, eight, nine, ten, and eleven sides were found.—Observations upon the development of the segmentation cavity, the archenteron, the germinal layers, and the amnion in mammals, by Dr. Arthur Robinson (Plates xxiii. to xxvii.). There is a general description of the development of the ova of the rat and mouse up to the period of the completion of the blastodermic vesicle, and a comparison with the results obtained by Fraser, Duval, and Selenka: there is a description of the formation of the mesoblast and of the chorda dorsalis, followed by a comparison of the ova of the rat and mouse with the ova of other mammals and the lower vertebrates and by a description of the formation of the amnion and a discussion of the relation of amnion formation to "inversion," and by a description of the formation of the cœlom.

June.—Contains:—On the primitive segmentation of the vertebrate brain, by Bertram H. Waters, B.A. (Plate xxviii.); concludes that the fore-brain is composed of at least two well-marked neuromeres, possibly of three; that the mid-brain consists of two neuromeres, from which there is every reason to think that the third and fourth nerves take their origin, and hence these deserve to be recognized as segmental structures; and that the hind brain consists of six neuromeres. On the oscula and anatomy of *Leucosolenia clathrus*, O.S., by E. A. Minchin, B.A. (Plate xxix.). In this sponge, in the fresh and healthy condition, not only are there oscula, "but in the full-sized specimens larger oscula than in any other Leucosolenia known to me, whether from pictures or in the flesh." These oscula are provided with a sphincter, and can be so tightly closed as to escape notice. Hæckel's four varieties of the sponge are only different states of contraction.—Researches into the embryology of the Oligochæta, No. 1: on certain points in the development of *Acanthodrilus multiporus*, by Frank E. Beddard, M.A. (Plates xxx. and xxxi.).—On the Innervation of the Cerata of some Nudibranchiata, by Dr. W. A. Herdman and J. A. Clutt (Plates xxxii. to xxxiv.). If the cerata of Nudibranchs cannot all be said to be true epipodia innervated by the pedals, it would seem equally impossible to regard them in all cases as pallial outgrowths supplied by the pleural ganglia. It is possible that they may have been epipodial in origin, although there be now, in some, a connection with pleural nerves.—Notes on Elasmobranch development, by Adam Sedgwick, M.A. (Plate xxxv.). On the paired nephridia of Prosobranchs, the homologies of the only remaining nephridium of most Prosobranchs, and the relations of the nephridia to the gonad and the genital duct, by Dr. R. v. Erlanger (Plates xxxvi. and xxxvii.).

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 16.—"The Physiological Action of the Nitrites of the Paraffin Series considered in connection with their Chemical Constitution. Part II. Action of the Nitrites on Muscular Tissue and Discussion of Results." By J. Theodore Cash, M.D., F.R.S., Professor of Materia Medica in the University of Aberdeen, and Wyndham R. Dunstan, M.A., Professor of Chemistry to the Pharmaceutical Society of Great Britain.

Continuing the examination of the physiological action of various pure organic nitrites of the paraffin series (Part I.; Roy. Soc. Proc., 1891), the authors have studied their effect on striated muscular tissue. When the vapours of these nitrites come into contact with the muscle a paralysant effect is observed. All the experiments were made with the triceps and gastrocnemius of *Rana temporaria*. The muscle was contained in a specially constructed air-tight chamber. A very extensive series of experiments was necessary in order to obtain reliable contrasts. The amounts of the nitrites employed varied between $\frac{1}{30}$ and $\frac{1}{200}$ c.c.

Several series of concordant results have thus been obtained which lead to two different orders of activity, viz. (1) with reference to the extent to which equal quantities of nitrites shorten the resting muscle, and (2) with reference to the rapidity with which the shortening is produced. The order of activity of the nitrites as regards the extent of the shortening they induce is as follows:—(i.) Iso-butyl, (ii.) tertiary amyl, (iii.) secondary butyl, (iv.) secondary propyl, (v.) propyl, (vi.) tertiary butyl, (vii.) butyl, (viii.) α-amyl, (ix.) β-amyl, (x.) ethyl, (xi.) methyl. The order representing the speed with which shortening occurs is (i.) methyl, (ii.) ethyl, (iii.) secondary propyl, (iv.) tertiary amyl, (v.) primary propyl, (vi.) tertiary butyl, (vii.) secondary butyl, (viii.) α-amyl, (ix.) β-amyl, (x.) primary butyl, (xi.) iso-butyl.

The effect of these nutrites in interfering with the active contraction of a stimulated muscle has also been studied, and it has been ascertained that very minute doses, insufficient to cause passive contraction, interfere in a marked degree with the active contraction, and cause the muscle to fail in responding to stimulation, whilst the companion muscle, contained in a closed chamber free from nitrite vapour, still responded to stimulation.

The remainder of the paper is devoted to a discussion of the connection between the various phases of physiological action and the chemical constitution of the nitrites which gave rise to them. The principal conclusions which have been arrived at are briefly as follows:—The physiological action of these nitrites is not solely, and in some cases not even mainly, dependent on the amount of nitroxyl (NO_2) they contain.

In respect of all phases of physiological activity, the secondary and tertiary nitrites are more powerful than the corresponding primary compounds. This is to be chiefly attributed not to the direct physiological action of the secondary and tertiary groups, but to the great facility with which these compounds suffer decomposition mainly into the alcohol and nitrous acid. In respect of the acceleration of the pulse, the power of the nitrites is directly as their molecular weight, and inversely as the quantity of nitroxyl they contain. They, therefore, fall into an order of physiological activity which is identical with that in which they stand in the homologous series. This same relationship holds, though less uniformly, in their power of reducing blood-pressure, and of inducing muscular contraction.

This order appears to be the result not so much of the direct physiological influence of the substituted methyl groups as of the increased chemical instability which their presence confers on the higher members of the series. In respect of the duration of subnormal pressure, as well as of the rapidity with which muscular contraction ensues, the activity of the nitrites is expressed by an order which is for the most part the reverse of that representing their power in accelerating the pulse, reducing blood-pressure, and contracting muscular fibre, this order being in general contrary to that of the homologous series. In these respects the more volatile nitrites of low molecular weight which contain relatively more nitroxyl are the most active. It appears probable that these simpler nitrites more readily attach themselves to certain constituents of blood and muscle, and thus act more quickly than the higher compounds, whilst their greater stability causes their effects, *i.e.*, reduction of blood-pressure, &c., to endure for a greater length of time than that of the higher and more easily decomposed bodies.

A large proportion of an organic nitrite is changed into nitrate in its passage through the organism, and is excreted as an alkali nitrate in the urine.

The results which have been gained by this research have an important bearing on the therapeutic employment of the nitrites. It is proposed elsewhere to consider what the outcome of this investigation is for practical medicine.

PARIS.

Academy of Sciences, July 25.—M. d'Abbadie in the chair. —Some new observations on the employment of the calorimetric shell, by M. Berthelot. Different bodies must be treated differently, according as they are fixed, volatile, or gaseous. For fixed compounds, solid or liquid, the ratio between the weight of the combustible and the weight of oxygen ought to be such that the gas which remains after combustion contains at least 60 per cent. of free oxygen; otherwise some half-burnt gases will remain in the vessel, notably carbonic oxide. Excess of oxygen, especially if under a pressure of 25 atmospheres, ensures that the temperature of the centre of combustion should remain as high as possible. In the case of gases the oxygen should only be in very slight excess, and should be introduced by tenths of an atmosphere, until the most favourable pressure is reached. Volatile bodies should, if possible, be burnt in the liquid state.—Study of boron trisulphide, by M. Henri Moissan. Five new methods of obtaining this body are described: by the action of fused sulphur on boron iodide; by burning boron in sulphur vapour at 610°; by the action of hydrogen sulphide on pure boron; by the action of carbon bisulphide on boron; and by the action of the sulphides of arsenic, antimony, and tin upon boron. The substance thus obtained shows several remarkable properties.—Researches on the chemical constitution of the peptones, by M. P. Schutzenberger.—On two ruminants of the Neolithic epoch of Algeria, by M. A. Pomel.—The two candidates selected for the Directorship of the Paris Observatory were M. Tisserand and M. Loewy.—*Résumé* of solar observations made at the Royal Observatory of the Roman College during the second quarter of 1892. A letter from M. P. Tacchini to the President. The spots, faculæ, and prominences observed show a considerable increase since last quarter.—Sun observations made at the Lyons Observatory (Brunner equatorial) during the first half of 1892, by M. Em. Marchand. 125 groups of sun-spots have been counted, as against 101 in the previous half-year. The southern hemisphere, which used to contain less spots, has lately shown nearly as many as the northern. The latitude of the groups continues to diminish.—New results with regard to hydrogen, obtained by the spectroscopic study of the sun. Similarity with the new star in the Charioteer, by M. Deslandres. In addition to the nine ultra-violet lines of hydrogen already known, five more have been photographed in the spectrum of a very brilliant prominence, extending up to the oscillation frequency 271,700. They correspond very closely with the frequencies calculated from Balmer's harmonic series. The interest of the discovery is augmented by the circumstance that the spectrum obtained shows a great similarity with that of the new star in the Charioteer.—On the velocity of propagation of the electromagnetic undulations in insulating media, and on Maxwell's relation, by M. R. Blondlot. Given an oscillator, the wave-length which it is susceptible of emitting remains the same, whatever may be the insulating medium in which the experiment is made.—On the heat of formation of permolybdic acid and the permolybdates, by M. E. Péchard.—On crystallized phosphide of mercury, by M. Granger.—On the mineralizing action of ammonium sulphate, by M. T. Klobb.—Micrographic analysis of the alloys, by M. Georges Guillemin.—On homopyrocatechine, and two derived nitrides of homopyrocatechine, by M. H. Cousin.—On a new class of combinations, the metallic nitrides, and on the properties of nitrogen peroxide, by MM. Paul Sabatier and J. B. Senderens.—The specific heat of the atoms and their mechanical constitution, by M. G. Hinrichs. On monopropyl urea and dissymmetrical dipropyl urea, by M. F. Chancel.—On the composition of fossil bones, and the variation in their percentage of fluorine during the various geological periods, by M. Adolphe Carnot.—Distribution and state of the iron in barley, by M. P. Petit.—On the comparative number of nerve fibres of cerebral origin serving as motor nerves for the upper and lower limbs of man respectively, by MM. Paul Blocq and M. J. Onanoff.—On the comparative toxic effects of the metals of the alkalies and of the alkaline earths, by M. Paul Binet.—Experimental regeneration of the sporogenic property of the *Bacillus anthracis*, previously deprived of it by heat, by M. C. Phisalix.—Excretion in the pulmonate gasteropods, by M. L. Cuénot.—On a colourless globuline which possesses a respiratory property, by M. A. B. Griffiths.—On the constitution of the cystoliths and of membranes encrusted with carbonate of lime, by M. Louis Mangin.—On a fresh-water perforating alga, by MM. J. Huber and F. Jadin.—On the causes of the catastrophe of St. Gervais (Haute-Savoie) on July 12, 1892, by MM. J. Vallot and A. Delebecque.—Contribution to the improvement of cultivated plants, by M. Schribaux.—The solar period and the last volcanic eruptions, by M. Ch. V. Zenger.

BERLIN.

Physiological Society, July 8.—Prof. Munck, President, in the chair.—Dr. Dessoir spoke on the sense of temperature regarded from the anatomical, psychological, and physiological point of view. He did not believe in the existence of separate senses for heat and cold since he had failed to obtain sensations of heat and cold by either mechanical or electrical stimulation of certain points of the skin. The temperature sense is localized, since portions of the body-surface can be found which are quite insensitive. The above communication was followed by a lengthy discussion.

July 22.—Prof. Munck, President, in the chair.—Prof. Zuntz had long ago observed that strong muscular exertion has a different effect on the alkalinity of the blood of carnivora as compared with herbivora; thus in dogs the power of their blood to absorb carbon dioxide was practically unaltered by exercise, whereas in rabbits it was considerably lessened. This point had recently been reinvestigated in the speaker's laboratory by Dr. Cohnstein, who found that the blood of a dog at hard work on a treadmill showed no alteration of alkalinity. The result was unaffected by diet, since it was the same when the dog was fed with meat alone, or with rice and fat. During very prolonged exertion the blood was finally found to possess an increased alkalinity. Dr. Lilienfeld had recently discovered Prof. Kossel's "histon" in the leucocytes of blood, united to neuclein as "nucleo-histon." Histon prevents the clotting of blood, whereas nuclein promotes the formation of fibrin. These two facts were regarded as explaining the various phenomena connected with blood clotting. Thus the blood is fluid in the blood vessels because nucleo-histon is retained by the leucocytes. On the other hand, when the blood is shed some of the leucocytes or platelets die, whereupon the nucleo-histon escapes into the plasma, is decomposed by the calcium salts there present into nuclein and histon, and the former (nuclein) then causes clotting. These facts also explain the action of calcium salts in promoting clotting. Prof. Zuntz stated that, according to his researches, a taste-sensation, as of something sweet, is very markedly increased when some other stimulus is simultaneously applied to the organ of taste, even when the stimulus is too weak to alone produce any sensation. Thus, for example, a solution of sugar tastes more sweet if it is mixed with some solution of common salt so weak that it excites no saline taste. The same result was obtained by the addition of a solution of quinine, also too weak to itself give rise to any sensation of taste.

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THURSDAY, AUGUST 11, 1892.

THE BRITISH ASSOCIATION.

EDINBURGH.

THE Edinburgh meeting has not been remarkable for a large turn-out of members. Probably the greatest number of members are present on the Friday, when practically all have come and none have left. At this high-water mark the number of members, associates, and holders of transferable ladies' tickets, was 2009, and although the tickets sold were increased to 2068 by Wednesday, the total attendance probably never quite reached 2000, which, although greater than last year's meeting at Cardiff, is much less than that twenty-one years ago at Edinburgh. Year by year the number of ladies taking part in the proceedings mounts steadily, and on several occasions the "popular" sections of anthropology and geography, which were frequently crowded, showed a great preponderance. Everything has not gone quite smoothly in spite of the efforts of the local secretaries. Edinburgh society is inelastic in its traditions, and Edinburgh institutions are ruled by rigid laws, which even a meeting of the British Association finds difficulty in relaxing. For the first day or two the reading and writing rooms and other apartments were closed at 5 p.m., as they occupy part of the Advocates' Library, while the reception-room being in Parliament House remained open for the usual time. Unqualified praise can be given to the commissariat arrangements. The main luncheon-room in the Students' Union was deservedly busy from 1 to 3. The handsome building containing these commodious rooms was greatly admired, and the enterprise of the students to whose efforts alone its construction is due, and by whom alone it is managed, was the subject of frequent comment. Passing between the section rooms and the Union members availed themselves of frequent opportunities to inspect the great MacEwen Hall of the University, now approaching completion, the prospective use of which, by the way, was one of the considerations that led the deputation from Edinburgh to defer to that from Cardiff in arranging the order of the Association's visits to the respective towns.

Rarely is it the privilege of the mixed multitude who throng the hall on the opening night of the meeting to listen to so comprehensible and attractive an address as the President delivered on this occasion. Sir Archibald Geikie's lucid exposition was crowned by a characteristically happy speech by Lord Kelvin in moving the vote of thanks. Altogether the first gathering dealt a blow at the belief, still amusingly common, that the true scientific man is a being of terms and formulæ, and that true science is colourless and unsympathetic. The other evening discourses were highly appreciated, and maintained the high character which the Association lectures have made for themselves. Prof. Milnes Marshall played upon his vague title of "Pedigrees" until the scintillations lit up a great part of the theory of evolution; while Prof. Ewing on Magnetic Induction threw a flood of light on what has hitherto been to ordinary minds one of the obscurest recesses of physics. The lecture to the working classes, from which members of the Association are excluded—unless they attend on false pretences—turned out a great success. Mr. Vernon Boys showed and explained his wonderful experiments on photographing bullets and the waves they produce in traversing the air with point and brilliancy. The work in some of the Sections has been of a high order of excellence; in Section A especially very few British physicists were absent, and some of the discussions alone justified the existence of the Association as a means of bringing men together from different working centres. The reading of the various reports in the different Sections in some cases gave rise to suggestions of high value for future work. Unfortunately, in consequence of the illness of the President, the address in the Geological Section was not read till Monday. It was not then quite complete, so its publication is postponed for the present.

Edinburgh, if possible, exceeded its old reputation for hospitality, and meetings of a purely social character were unusually numerous, and the two conversaziones proved thoroughly enjoyable.

Excursions practically took up the whole of Saturday, and an unusually large number took advantage of the opportunity for visiting the many scenes of historical, archæological, geological, and engineering interest which lie around Edinburgh. The range was by no means restricted to the immediate vicinity, the excellent railway arrangements permitting of visits to Glasgow, Dundee, and the land of Scott, with no greater expenditure of time than the carriage parties demanded for visiting the Forth Bridge and Roslin, or the pedestrians for geologizing in the Pentlands and on Arthur's Seat. The weather for the first few days was favourable, being dry and free from excessive heat. But Monday was a most unfortunate sample of Edinburgh's weather at its worst, strong east wind and cold continual showers; even this state of matters failed to empty the section-rooms where papers of popular interest were being read. Afternoon receptions both public and private, were particularly well managed, perhaps the most enjoyable being that given by the Royal Scottish Geographical Society in the spacious halls of the National Portrait Gallery, where the Antiquarian Museum is now worthily housed. A special reception of foreign members was also given by the University in the Library Hall. The number of distinguished foreigners present marked out this meeting from most others of recent years. The Prince of Monaco, who, with the princess, lived on board his new yacht the *Princesse Alice*, was perhaps the greatest attraction, and he succeeded in bringing together one of the largest audiences to listen to his papers in Section E. He also showed his yacht to a select party of members specially interested in marine studies, and took endless trouble in explaining the ingenious original devices for deep-sea research with which she is fitted. Profs. von Helmholz, Wiedemann, von Richthofen, Ostwald, and Goebel worthily represented the science of German Universities, and many of their somewhat less distinguished colleagues were also present. Baron de Guerner, MM. de Margine, Demolins, Bertrand, Manouvrier, Guillaume, and Richard came from France, the Abbé Renard and Profs. Errera and Hulin from Belgium, Drs. Arrhenius and Pettersson from Sweden, Prof. Fritsch and others well known in the scientific world from Austria, while the United States, Holland, Russia, and Switzerland were also represented. The brilliant young physicist, Nikola Tesla, appears in the list as a visitor from America.

A small meeting unfortunately means a small sum available for grants to scientific workers, and on account of the large sums asked for by the various Sections, the work of the Committee of Recommendations was no sinecure.

Next year's meeting will be held at Nottingham, and that for 1894 at Oxford.

The list of awards finally arrived at was as follows:—

Investigation of the Eruptive Deposits of Pentland Hills	£10
Isomeric Naphthalene Derivatives	20
Index of Plants, &c.	20
Climatology, &c., of Africa	50
Place Names in Scotland	10
Electrical Measurements	25
Observations on Ben Nevis	150
Falmouth Observatory	25
Photography of Meteorological Phenomena	10
Solar Radiation	10
Spectra of Elements	10
Analyses of Iron and Steel	20
Action of Light on Dyed Colours	5
Erratic Blocks of England, Wales, and Ireland	10
Fossil Phyllopoda	5
Geological Intervals	10
Underground Waters...	5
High-level Shell-bearing Deposits	20
Zoological Station at Naples	100
Plymouth Biological Station	30
Sandwich Islands	100
West Indies	50
Irish Sea Exploration	30
Oxygen in Asphyxia	20
Exploration of the Karakorum Mountains	50
Methods of Economic Training	5
Anthropometric Tabulations	5
Exploration of Assam	25
North-West Tribes of Canada	100
Natives of India	10
Corresponding Societies Committee	30
Total ...	£970

SECTION D.

BIOLOGY.

OPENING ADDRESS BY PROF. WILLIAM RUTHERFORD, M.D., F.R.S., PRESIDENT OF THE SECTION.

AT the meeting of this Association held at Birmingham in 1886 I had the honour of delivering a lecture on the Sense of Hearing, in which I criticized the current theory of tone-sensation, and I propose on this occasion to discuss the current theories regarding our sense of colour.

I may premise that our conceptions of the outer world are entirely founded on the experience gathered from our sensory impressions. Through our organs of sensation, mechanical, chemical, and radiant energies impress our consciousness. The manner in which the physical agents stimulate the peripheral sense-organs, the nature of the movement transmitted through our nerves to the centres for sensation in the brain, the manner in which different qualities of sensation are there produced—all these are problems of endless interest to the physiologist and psychologist.

Every psychologist has acknowledged the profound significance of Johannes Müller's law of the specific energies—or, as we should rather say, the specific activities of the sense-organs. To those unfamiliar with it, I may explain it by saying, that if a motor nerve be stimulated, the obvious result is muscular movement; it matters not by what form of energy the nerve is stimulated—it may be by electricity or heat, by a mechanical pinch or a chemical stimulus, the specific result is muscular contraction. In like manner, when the nerve of sight is stimulated—it may be by light falling on the retina, or by electricity, or mechanical pressure, or by cutting the nerve—the invariable result is a luminous sensation, because the impression is transmitted to cells in the centre for vision in the brain, whose specific function is to produce a sense of light.

The same principle applies to the other sensory centres; when thrown into activity, they each produce a special kind of sensation. The sun's rays falling on the skin induce a sense of heat, but falling on the eye, they induce a sense of sight. In both cases the physical agent is the same; the difference of result arises from specific differences of function in the brain centres concerned in thermal and visual sense. We have no conception how it is that different kinds of sensation arise from molecular movements in the different groups of sensory cells; we are as ignorant of that as we are of the nature of consciousness itself.

The subject I propose to discuss on this occasion is not the cause of the different *kinds* of sensation proper to the different sense-organs, but the causes of some *qualities* of sensation producible through one and the same sense-organ.

The theory of tone-sensation proposed by Helmholz is, that the ear contains an elaborate series of nerve terminals capable of responding to tones varying in pitch from 16 vibrations to upwards of 40,000 vibrations per second, and that at least one different fibre in the auditory nerve, and at least one different cell in the centre for hearing, is affected by every tone of perceptibly different pitch. Although the physical difference between high and low tones is simply a difference in frequency of the sound waves, that is not supposed by Helmholz to be the cause of the different sensations of pitch. According to his theory, the function of frequency of vibration is simply to excite by sympathy different nerve terminals in the ear. The molecular movement in all the nerve fibres is supposed to be identical, and the different sensations of pitch are ascribed to a highly specialized condition of cells in the hearing centre, whereby each cell, so to speak, produces the sensation of a tone of definite pitch, which in no way depends on the frequency of incoming nerve impulses, but simply on the specific activity of the cell concerned.

In my lecture on the Sense of Hearing I pointed out in detail the great anatomical difficulties attending the theory in question. I endeavoured to show the physical defect of a theory which does not suppose that our sensations of harmony and discord must immediately depend upon the numerical ratios of nerve vibrations transmitted from the ear to the central organ, and I offered a new theory of hearing based upon the analogy of the telephone. According to that theory, there is probably no analysis of sound in the ear; the air-cells at the peripheral ends of the auditory nerve are probably affected by every audible sound of whatever pitch. When stimulated by sound they probably produce nerve vibration, simple or compound, whose frequency, amplitude, and wave-form correspond to those of the sound received. The nerve vibrations arriving in the cells of the auditory centre probably induce simple sensations of tones of different pitch, or compound sensations of harmonies or discords strictly dependent on the relative frequencies of the nerve vibrations coming in through the nerve.

I cannot now recapitulate the evidence derived from anatomical, experimental, and pathological observations that give support to my theory of hearing, but I may briefly say that it is opposed to the theory of specific activities, in so far as it has been applied to explain the different qualities of sound sensation. It is, however, in strict accord with the fundamental proposition stated by Fechner[1] in his great work on Psychophysics in these words: "The first, the fundamental hypothesis is, that the activities in our nervous system on which the sensations of light and sound functionally depend are, not less than the light and sound themselves, to be regarded as dependent on vibratory movements." It is evident that, if we could only comprehend the nature of the molecular movement in the nerve that links the vibration of the physical agent to that in the sensory cell, we could advance towards a true theory of the physiological basis of different qualities of sensation in the different sense-organs. As yet no definite answer can be given to the question, what sort of molecular movement constitutes a nerve impulse, but in recent years our knowledge of the subject has been extended in a direction that opens up a vista of new possibilities.

A nerve impulse travels at a rate not much more than 100 feet per second—an extremely slow speed compared with that of electricity in a wire. It has been thought to be of the nature of a chemical change sweeping along the nerve, but that hypothesis is opposed by the fact that the most delicate thermopile shows no production of heat, even when an impulse is caused to sweep repeatedly along the same nerve. Again, it is far easier to fatigue a muscle than a nerve. A living frog's nerve removed from the animal, and therefore deprived of all nutrition, can retain its excitability for nearly an hour, although subjected all the while to thirty or forty stimulations per second. An excised muscle, when similarly stimulated, is exhausted far sooner, because the mechanical energy entirely springs from chemical change in the muscular substance, and therefore the muscle is more easily fatigued than the nerve. The molecular motion in an excited nerve produces a momentary electric current; but that result is not peculiar to nerve. The same occurs in muscle when stimulated. Possibly the molecular movement is of the nature of a mechanical vibration; at all events, we know now that a nerve can transmit hundreds, even thousands of impulses, or let us simply say vibrations, per second. The fact is so important and significant in relation to the physiology of the sense organs, that I show you an experiment to render it more intelligible. A frog's muscle has been hooked to a light lever to record its movement on a smoked cylinder. The nerve of the muscle has been laid on two electrodes connected with the secondary coil of an induction machine. In the primary circuit a vibrating reed has been introduced to serve as a key for making and breaking the circuit, and so stimulating the nerve with periodic induction shocks. If we make the reed long enough to vibrate ten times per second, ten impulses are sent through the nerve to the muscle and ten distinct contractions produced, as shown by the wavy line upon the cylinder. If we shorten the reed so that it will vibrate, say, fifty times per second, the muscle is thrown into a continuous contraction and traces a smooth line on the cylinder; but if we listen to the muscle we can hear a tone having a pitch of fifty vibrations per second, from which we know that fifty nerve impulses are entering the muscle and inducing fifty shocks of chemical discharge in the muscular substance. If we take a reed that vibrates, say, 500 times per second, we hear, on listening to the muscle, a tone having the pitch of 500 vibrations. Observe, that we are not dealing with the transmission of electrical shocks along the nerve, but with the transmission of nerve impulses. By stimulating the nerve with wires of a telephone it has been shown by D'Arsonval that a nerve can transmit upwards of 5000 vibrations per second, and that the wave-forms may be so perfect that the complex electrical waves produced in the telephone by the vowel sounds can be reproduced in the sound of a muscle after having been translated into nerve vibrations and transmitted along a nerve. Such experiments go far in helping us towards a comprehension of the capabilities of nerves in transmitting nerve vibrations of great frequency and complicated wave form; but although they enable us reasonably to suppose that all the fibres of the auditory nerve can transmit nerve vibrations, simple or complex, and with a frequency similar to that of all audible tones, we encounter superlative difficulty in applying such a theory to the sense of sight. In objective sound we have to deal with a comparatively simple wave motion, whose frequency of vibration is not difficult to grasp even at the highest limit of audible sound—about 40,000 vibrations per second. But in objective light the frequency of vibration is so enormous—amounting to hundreds of billions per second—that every one feels the difficulty of forming any conception of the manner in which different frequencies of ether waves induce differences in colour sensation.

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[1] "Elemente der Psychophysik," 1860 2nd edition, 1889, part ii. p. 282.

But before passing to colour sense, I wish to allude for a moment to the sense of smell. The terminals of the olfactory nerve in the nose are epithelial cells. It has been recently shown by Von Brunn [1] that in man and other mammals the cells have at their free ends very delicate short hairs, resembling those long known in lower vertebrates. These hairs must be the terminal structures affected by substances that induce smell, and are therefore analogous to the hairs on the terminal cells in our organ of hearing. No one ever suggested that the hairs of the auditory cells can analyze sounds by responding to particular vibrations, and I think it quite as improbable that the hairs on any particular olfactory cell respond to the molecular vibrations of any particular substance. If we follow those who have had recourse to the doctrine of specific activities to explain the production of different smells, we must suppose that at least one special epithelial cell and nerve fibre are affected by each different smelling substance. Considering how great is the variety of smells, and that their number increases with the production of new substances, it would be a somewhat serious stretch of imagination to suppose that for each new smell of a substance yet to emerge from the retort of the chemist there is in waiting a special nerve terminal in the nose. It seems to me far simpler to suppose that all the hairs of the olfactory cells are affected by every smelling substance, and that the different qualities of smell result from difference in the frequency and form of the vibrations initiated by the action of the chemical molecules on the olfactory cells and transmitted to the brain. That hypothesis was, I believe, first suggested by Prof. Ramsay,[1] of Bristol, in 1882, and it seems to me the only intelligible theory of smell yet offered. But it must be admitted that a theory of smell, such as that advanced by Ramsay, involves a more subtle conception of the molecular vibrations in nerve fibrils than is required in the case of hearing. It involves the conception that musk, camphor, and similar substances produce their characteristic qualities of smell by setting up nerve vibrations of different frequencies and probably of different complexities. We shall see what bearing this may have on the theory of colour sense, to which I now pass.

No impressions derived from external Nature yield so much calm joy to the mind as our sensation of colour. Pure tones and perfect harmonies produce delightful sensations, but they are outrivalled by the colour effects of a glorious sunset. Without our sense of colour all Nature would appear dressed in bold black and white, or indifferent grey. We would recognize, as now, the beauty of shapely forms, but they would be as the cold engraving contrasted with the brilliant canvas of Titian. The beautiful tints we so readily associate with natural objects are all of them sensations produced in our brain. Paradox though it appear, all Nature is really in darkness. The radiant energy that streams from a sun is but a subtle wave-motion, which produces the common effects of heat on all bodies, dead or living. It does not dispel the darkness of Nature until it falls on a living eye, and produces the sense of light. Objective light is only a wave motion in an ethereal medium; subjective light is a sensation produced by molecular vibration in our nerve apparatus.

The sensory mechanism concerned in sight consists of the retina, the optic nerve, and the centre for visual sensation in the occipital lobe of the brain. In the vertebrate eye the fibres of the optic nerve spread out in the inner part of the retina, and are connected with several layers of ganglionic cells placed external to them. The light has to stream through the fibres and ganglionic layers to reach the visual cells—that is, the nerve terminals placed in the outer part of the retina. They may be regarded as epithelial cells, whose peripheral ends are developed into peculiar rod- and cone-shaped bodies, while their central ends are in physiological continuity with nerve fibrils. Each rod and cone consists of an inner and an outer segment. The outer segment is a pile of exceedingly thin, transparent, doubly refractive discs, colourless in the cone, but coloured pink or purple in the rod. In man, the inner segment of both rod and cone is colourless and transparent. Its outer part appears to be a compact mass of fine fibrils that pass imperceptibly into the homogeneous-looking protoplasm in the shaft of the cell. Owing to the position of the rods and cones, the light first traverses their inner, then their outer segments, and its unabsorbed portion passes on to the adjacent layer of dark-brown pigment cells by which it is absorbed. It is not necessary for me to discuss the possible difference of function between the rods and cones. I may simply say that in the central part of the yellow spot of the retina, where vision is most acute, and from which we derive most of our impressions of form and colour, the only sensory terminals are the cones. A single cone can enable us to obtain a distinct visual impression. If two small pencils of light fall on the same cone the resulting sensory impression is single. To produce a double impression the luminous pencils must fall on at least two cones. That shows how distinct must be the path pursued by the nerve impulse from a visual cell in the yellow spot of the retina to a sensory cell in the brain. The impulses from adjacent terminals must pursue their own discrete paths through the apparent labyrinth of nerve fibrils and ganglion cells in the retina to the fibres of the optic nerve. How these facts bear on the theory of colour sense will presently be apparent. Meantime I pass to the physical agent that stimulates the retina.

When a beam of white light is dispersed by a prism or diffraction grating, the ether-waves are spread out in the order of their frequency of undulation. The undulations of radiant energy extend through a range of many octaves, but those able to stimulate the retina are comprised within a range of rather less than one octave, extending from a frequency of about 395 billions per second at the extreme red to about 757 billions at the extreme violet end of the visible spectrum. The ultra-violet waves in the spectrum of sunlight extend through rather more than half an octave. Although mainly revealed by their chemical effects, they are not altogether invisible: their colour is bluish-grey. The only *optical*—that is, strictly *physical*—difference between the several ether-waves in the visible or invisible spectrum is frequency of undulation, or, otherwise expressed, a difference in wave-length. The *chromatic*—that is the colour-producing—effects of the ether-waves depend on their power of exciting sensations of colour, which vary with their frequency of undulation.

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[1] Von Brunn, *Archiv für mikroskopische Anatomie*, 1892, Band 39.

[1] Ramsay, NATURE, 1882, vol. xxvi. p. 189.

Although the retina is extremely sensitive to differences in the frequency of ether-waves, it is not equally so for all parts of the spectrum. In the red and blue portions, the frequency varies considerably without producing marked difference of colour effect, but in the region of yellow and green, comparatively slight variations in frequency produce appreciable differences of colour sensation. One striking difference between the effect of ether-waves on the eye and sound waves on the ear is the absence of anything corresponding to the octave of tone sensation. The ether-waves in the ultra-violet, which have twice the frequency of those of the red end of the spectrum, give rise to no sense of redness, but merely that of a bluish-grey. Even within the octave there are no harmonies or discords of colour sense corresponding to those of tone sensation.

Colours are commonly defined by three qualities or constants,—hue, purity, and brightness. Their hue depends upon the chromatic effect of frequency of undulation or wave length. Their purity or saturation depends on freedom from admixture with sensations produced by other colours or by white light. Their brightness or luminosity depends on the degree to which the sensory mechanism is stimulated. The loudness of sound depends on the amount of excitement produced in the auditory mechanism by the amplitude of sound waves; but a sound with small amplitude of undulation may seem loud when the nerve apparatus is unduly sensitive. The brightest colour of the spectrum is orange-yellow, but it does not follow that the amplitude or energy of the ether-waves is greater than in the region of dull red. There is no physical evidence of greater amplitude in the orange-yellow, and its greater luminosity is no doubt purely subjective, and arises from the greater commotion induced in the sensory mechanism.

The theory of colour sense long ago proposed by Sir Isaac Newton[1] is now commonly treated with what seems to me very undeserved neglect. Newton supposed that the rays of light induce vibrations in the retina which are transmitted by its nerve to the sensorium, and there induce different colour sensations according to the length of the incoming vibrations—the longest producing sensations of red and yellow, the shortest blue and violet, those of medium length a sense of green, and a mixture of them all giving a sense of whiteness. At the beginning of this century Thomas Young proposed a theory which seems to have been intended as a modification of that suggested by Newton rather than as a substitute for it. Young supposed that the ether-waves induce vibrations in the retina "whose frequency must depend on the constitution of its substance; but as it is almost impossible to conceive that each sensitive point of the retina contains an infinite number of particles, each capable of vibrating in unison with every possible undulation, it becomes necessary to suppose the number limited to three primary colours, red, yellow, and blue, and that each sensitive filament of the nerve may consist of three portions, one for each principal colour."[2] Soon afterwards he substituted green for yellow, and violet for blue, so that he came to regard red, green, and violet as the three fundamental colour sensations, by mixture of which in varying proportions, all other colours, including white, are produced. Young believed that his suggestion "simplified the theory of colours, and might therefore be adopted with advantage until found inconsistent with any of the phenomena."

Young's trichromic theory of colour sense was adopted by Clerk-Maxwell and Von Helmholz, and underwent important amplification. Helmholz suggested that the three sets of fibres supposed by Young to exist in the optic nerve are connected with three sets of terminals in the retina; that each terminal contains a different visual substance capable of being decomposed by light; that when the substance in the red nerve terminal undergoes chemical change its nerve fibre is stimulated, and the excitement travels to a cell in the brain by whose specific activity the sensation of red arises. In like manner, when the visual substances in the green and violet terminals are decomposed, nerve impulses travel through different fibres to different cells in the vision centre, by whose specific activities the sensations of green and violet arise. With Helmholz there was no question as to difference in quality of sensation depending on difference in frequency of nerve vibration arriving in the sensorium; no such hypothesis was entertained by him either for tone or for colour sensation. With sight, as with hearing, he supposed that the function of frequency of undulation virtually stops at the nerve terminals in the eye and ear, and that the frequency of undulation of the physical agent has no correlative in the quality of motion passing from the receiving terminal to the sensory cell. He believes that the different frequencies of ether-waves simply excite chemical changes in different nerve terminals. He expressly states[1] that the molecular commotion in the nerve fibres for red, green, and violet is identical in kind, and that its different effects depend on the specific activities of the different cells to which it passes in the sensorium. It is evident that Helmholz entirely dismissed the Newtonian theory of the production of different qualities of colour sense, and substituted for it the doctrine of his own great teacher, Johannes Müller.

The theory of Young and Helmholz offers an explanation of so many facts, and has at the same time provoked so much criticism, that I must enter more fully into some of its details. On this theory, the sense of white or grey is supposed to result from a simultaneous and duly balanced stimulation of the red, green, and violet terminals. The red terminals are supposed to be excited chiefly by the longer waves in the region of the red, orange, and yellow, but also by the shorter undulations extending as far as Fraunhofer's line F at the beginning of the blue. In like manner, the green terminals are excited chiefly by the waves of medium length, and to a less extent by the waves extending to C in the red, and by the shorter waves extending to G in the violet. The violet terminals are stimulated most powerfully by the shorter undulations between F and G, but also by the longer ones reaching as far as D in the yellow; therefore, optically homogeneous light from any part of the spectrum, except its extreme ends, does not usually give rise to a pure colour sensation; all three primary sensations are present, and consequently the colour inclines towards white—the more, the stronger the light.

The experimental facts in support of Young's theory are familiar to all who have studied physics. Compound colour sensations may be produced by causing light of different wave lengths to fall simultaneously or in rapid succession on the same part of the retina. The commonest experimental device is to rapidly whirl discs with sectors of different colours, and observe the results of the mixed sensations; or to cause the images of coloured wafers or papers to fall simultaneously on the retina by Lambert's method; or to transmit light through glass of different colours, and cause the different rays to fall on the same surface; or to mix pure homogeneous light from different parts of the spectrum. For obvious reasons, the last method yields the most trustworthy results. We cannot, by any mixture of homogeneous light from different parts of the spectrum, obtain a pure red or green sensation, and according to Helmholz, the same holds true of violet. On the other hand, a mixture of homogeneous rays from the red and green parts produces orange or yellow, according to the proportions employed. A mixture of rays from the green and violet gives rise to intermediate tints of blue, and a mixture of red and violet light produces purple. Therefore, Young regarded red, green, and violet as primary sensations, and orange, yellow, and blue—just as much as purple—he regarded as secondary or compound sensations. Helmholz discovered that to obtain a sense of white or grey it is not necessary to mingle rays from the red, green, and violet portions of the spectrum. He found that he could obtain a white sensation by mixing only *two* optically homogeneous rays from several parts of the right and left halves of the spectrum. The pairs of spectral colours which he found complementary to each other are, red and greenish-blue, orange and cyan-blue, yellow and ultramarine-blue, greenish-yellow and violet; the complement for pure green being found not in any homogeneous light, but in purple—a mixture of red and violet. The complementary colours may be arranged in a circle, with the complementaries in each pair placed opposite one another. Of course, the circle cannot be completed by the colours of the spectrum; purple must be added to fill in the gap between the red and violet. Helmholz found no constant ratios between the wave lengths of homogeneous complementaries; and it is a striking fact that, while a mixture of the green and red, or of the green and violet undulations gives rise to a sensation such as could be produced by rays of intermediate wave length, no such effect follows the mingling of rays from opposite halves of the spectrum. Pure green, with a wave length of 527 millionths of a millimetre, marks the division between the right and left halves. The mixture of blue from the right and yellow from the left side does not produce the intermediate green, but a sensation of white. A mixture of blue or violet and red produces not green, but its complementary—purple. On the trichromic theory, the sense of white produced by the mingling of any of these two colours is simply regarded as the result of a balanced stimulation of the red, green, and violet terminals.

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[1] See quotations from Newton made by Young in Reference 2.

[2] Thomas Young, "On the Theory of Light and Colours," *Phil. Trans. Lond.*, 1802, p. 12.

[1] Von Helmholz, *Handbuch der physiologischen Optik*, 2nd edition, 1892, p. 350.

But Young's theory is beset with serious difficulties. It implies the existence of three sets of terminals in the retina, and these must all be found in the central part of the yellow spot where cones alone are present. Three sets of cones there would be necessary to respond to the red, green, and violet light, and a colourless pencil of light could not be seen uncoloured, unless it falls on three cones, which we know from astronomical observations is not the case. Therefore, if there are three different terminals, it seems necessary, in the human retina at all events, that they should be found in every single cone in the yellow spot. But I cannot believe it possible that within a single cone there can be three sets of fibrils capable of simultaneous stimulation in different degrees, and of ultimately transmitting impulses through three different fibres to three different cells in the brain. That would imply a greater number of fibres in the optic nerve, than of terminals in the retina, and we know that precisely the reverse is the case. The anatomical difficulty is therefore great, and I am unable to see how it can be surmounted.

The phenomena of colour-blindness also offer great difficulty. In several cases of apoplectic seizure it has happened that the centre for vision on both sides of the brain has been completely or partially paralyzed by the extravasated blood. In such cases the sense of colour may be entirely lost either for a time or permanently, while the sense of light and form remain—although impaired. The loss of colour sense in some cases has been found complete in both eyes; in most of the recorded cases the loss of colour sense was limited to the right or left halves of both eyes; that is, if the lesion affected the vision centre on the right side of the brain, the right halves of both eyes were blind to all colours. That illustrates the fact that a sense of light does not necessarily imply a sense of colour. The colour sense probably involves a more highly refined action of the sensory cell than the mere sense of light and form, and is on that account more liable to be lost when the nutrition of the sensory cell is interfered with. In the normal eye the peripheral zone of the retina is totally blind to colour. If you turn the right eye outwards, close the left, and then move a strip of coloured paper from the left to the right in front of the nose, the image of the paper will first fall on the peripheral zone of the retina, and its form will be seen, though indistinctly, but not its colour. It is difficult to say in that case whether the colour-blindness is due to the state of the retina or to that portion of the vision centre in the brain associated with it. The absence of cones from the peripheral part of the retina has been assigned as the cause, but it is much more probable that the portion of the vision centre associated with the periphery of the retina, being comparatively little used, is less highly developed for form sensation, and not at all for colour sense. It is evident that the production of a sense of white or grey in the absence of all colour sense is not to be explained on the theory that it results from a balanced stimulation of red, green, and violet nerve terminals.

I need scarcely say that colour-blindness has attracted a large share of attention, not only because of its scientific interest, but still more on account of its practical importance in relation to the correct observation of coloured signals. In 1855 the late Prof. George Wilson,[1] of this city, called attention to the growing importance of the subject. Some years ago Prof. Holmgren made an elaborate statistical inquiry regarding it at the instance of the Swedish Government, and lately it has been investigated by a committee of the Royal Society of London, who have quite recently published their report.[1]

Although colour-blindness occasionally results from disease of the brain, retina, or optic nerve, it is usually congenital. Total colour-blindness is extremely rare, but partial colour-blindness is not uncommon. It occurs in about 4 per cent. of males, but in less than 1 per 1000 of females. Its most common form is termed red-green blindness, in which red and green sensations appear to be absent. So far as I can find, the first full and reliable account of the state of vision in red-green blindness is that given in 1859 by Mr. Pole,[2] of London, from an examination of his own case, which appears to be a typical one. The state of his vision is dichromic; his two-colour sensations are yellow and blue. The red, orange, and yellowish-green parts of the spectrum appear to him yellow of different shades. Greenish-blue and violet appear blue, and between the yellow and blue portions of the spectrum, as it appears to him, there is a colourless grey band in the position of the full green of the ordinary spectrum. This neutral band is seen in the spectrum in all cases of dichromic vision. It may appear white or grey according to the intensity of the light, and it apparently results from an equilibrium of the two sensations; no such band is seen in the spectrum by a normal eye. Mr. Pole, in the account of his case given now three and thirty years ago, considered it impossible to explain his dichromatic vision on the commonly received theory that his sense of red is alone defective, and that his sense of yellow is a compound of blue and green. He believed his green quite as defective as his red sensation, and that yellow and blue are quite as much entitled to be considered fundamental sensations as red and green. He suggested that in normal colour vision there are at least four primary sensations—red and green, yellow and blue. Prof. Hering is commonly accredited with the four-colour theory, but it was previously suggested by Pole.[3]

A year after Pole's paper appeared, Clerk-Maxwell[4] published his celebrated paper on the theory of compound colours, to which he appended an account of his observations on a case of what he believed to be red-blindness, but which we now know must have been red-green blindness. The spectrum appeared dichromic, its only colours being yellow and blue. His description of the case does not materially differ from that given by Pole; but Clerk-Maxwell believed in the trichromic theory of normal vision, and that red-green and blue are the three primary sensations; consequently he supposed that the yellow sensation of a red blind person is not pure yellow, but green.

It is evident that much depends on the question, "Is the yellow sensation of a red-green blind person the same as that of normal vision?" For many years it was impossible to give a definite answer to that question, but the answer can now be given, as we shall immediately see. Colour-blindness is frequently hereditary, and two or three cases are known in which the defective colour sense was limited to one eye, while in the other eye colour vision was normal. In such a case observed by Prof. Hippel, of Giessen, there was red-green blindness in one eye. Holmgren, who examined Hippel's case, has published an account of it.[5] With one eye all the colours of the spectrum were seen, but to the other eye the spectrum had only two colours with a narrow grey band between them at the junction of the blue and yellow. The yellow seen by the eye with the red-green defect had a greenish tinge like that of a lemon, but in other respects the observations confirmed Pole's account of his own case.

Hippel's case seems to me important for another reason. By some it is believed that congenital colour defect is due to the brain. If there had been defective colour sense on one side of the brain, it would not have implicated the whole of one eye, but the half of each eye. Its limitation to one eye, therefore, seems to me to suggest that the fault was in the eye rather than in the brain.

Another interesting fact in this relation is that in every normal eye, just behind the peripheral zone of total colour-blindness, to which I have already referred, there is a narrow zone in which red and green sensations are entirely wanting, while blue and yellow sensations are normal. Possibly the red-green defect is due to an imperfectly developed colour sense in the portion of the vision centre connected with that zone of the retina, but Hippel's case seems to me to show that such defect might be on the retina.

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[1] Wilson, "Researches on Colour-Blindness," Edinburgh, 1835.

[1] "Report of the Committee on Colour Vision," Proc. Roy. Soc. Lond., July 1892.

[2] W. Pole, "On Colour-Blindness," Phil. Trans., 1859, vol. cxlix. p. 323.

[3] *Ibid.*, p. 331.

[4] Clerk-Maxwell, "On the Theory of Compound Colours," &c., Phil. Trans., 1860, vol. cl., p. 57.

[5] F. Holmgren, "How do the Colour-Blind see the Different Colours?" Proc. Rov. Soc. Lond., 1881, vol. xxxi. p. 302.

It has probably already struck you that red-green blindness is really blindness to red, green, and violet, that Young's three primary sensations appear to be absent, and the two remaining colours are those which he regarded as secondary compounds of his primaries.

That, however, is not all that is revealed by colour-blindness. There is at least another well-known though rare form in which a sense of yellow, blue, and violet is absent, and the only colour sensations present are red and green. The defect is sometimes termed violet blindness, but the term is somewhat misleading. It is much more in accordance with the fact to term it yellow-blue blindness; indeed, we would define it precisely by terming it yellow-blue-violet blindness. Holmgren[1] has recorded a unilateral case of that defect analogous to Hippel's case of unilateral red-green defect; we therefore know definitely how the spectrum appears to such a person. In the case referred to all the colours of the spectrum were seen with the normal eye, but to the other eye the spectrum had only two colours, red and green. The red colour extended over the whole left side of the spectrum to a neutral band in the yellow-green, a little to the right of Fraunhofer's line D. All the right side of the spectrum was green as far as the beginning of the violet, where it "ended with a sharp limit (about the line G)."

If you turn to the Report of the Royal Society's Committee[2] on Colour Vision, you will find the spectrum as it appears to yellow-blue-violet blind persons. The plate agrees with the description of Holmgren's case already given; but you will not find a representation of the spectrum as it appears to those who are red-green blind, and as described by Pole and others. In place of it you will find two dichromic spectra, one with a red and blue half said to be seen by a green blind, the other with a green and a blue half said to be seen by a red blind person. We have copied the spectra for your inspection, and you will observe that yellow does not appear in either of them. I do not for a moment pretend to criticize these spectra from any observations of my own; I am aware Holmgren maintains that red-and-green blindness may occur separately; but, on the other hand, Dr. George Berry, an eminent ophthalmologist, has assured me that he has always found them associated. That statement was originally made by Hering.

Of the various methods of testing colour vision, that suggested by Seebeck is most commonly employed. The individual is mainly tested with regard to his sense of green and red. He is shown skeins of wool, one pale green, another pink or purple, and a third bright red, and he is asked to select from a heap of coloured wools, laid on a white cloth, the colours that appear to him to match those of the several tests. We have arranged such test skeins for your inspection, and have placed beneath each of them the colours which a red-green blind person usually selects as having hues similar to those of the test. It is startling enough to find brown, orange, green, and grey confused with bright red; pale red, orange, yellow, and grey confused with green; blue, violet, and green confused with pink; but these confusions have all their explanation in the fact that the red-green blind have only two colour-sensations—yellow and blue, with a grey band in what should have been the green part of his spectrum.

We have now to show you another and far more beautiful method of ascertaining what fundamental colour sensations are absent in the colour-blind. It is the method of testing them by what Chevreul long ago termed *simultaneous contrast*. If in a semi-darkened room we throw a beam of coloured light on a white screen and interpose an opaque object in its path, the shadow shows the complementary colour. If the light be red, the shadow appears green-blue; if it be green, the shadow appears purple or red according to the nature of the green light employed. If the light is yellow, the shadow is blue; if it is blue, the shadow is yellow. We must remember that the part of the screen on which the shadow falls is not entirely dark; a little diffuse light falls on the retina from the shadowed part, so that the retina and vision centre are slightly stimulated, whereby the image of the shadow.

The experiment can be rendered still more striking, though at the same time a little more complicated, by using two oxy-hydrogen lamps and throwing their light on the same portion of the screen. If a plate of coloured—say ruby—glass is held before one of the lamps, and an opaque object such as the head of a T-square is placed in the path of both lights, the shadow cast by the white light falls on a surface illuminated by a red light, and shows a deep red far more saturated than the surrounding surface of the screen where the red and white lights fall. The shadow cast by the red light shows the complementary bluish green; and the contrast of the two is exceedingly striking.

These experiments we have shown you point to some subtle physiological relations between complementary colours. A colour sensation produced in one part of the vision apparatus forces, so to speak, the neighbouring part, which is relatively quiescent, to produce the complementary colour subjectively. I say *vision-centre* rather than *retina*, because, if one eye is illuminated with coloured light while the other eye is feebly illuminated with white light, the complementary colour appears in the centre belonging to that eye. The sense of white appears to be a mysterious unity; if you *objectively* call up one part of the sensation, you call up its counterpart *subjectively*. If a colour and its complementary counterpart be both displayed objectively at the same time, the action and reaction of effect afford a sensation far more agreeable than is producible by the objective display of only one of them. The agreeableness of the contrast of complementary colours, no doubt, springs from the harmony of effect. There is no harmony of colour effect analogous to that of music, but there is harmony of a different kind, and that harmony is formed by the contrast of complementary colours.

Now I imagine many of you have already anticipated the question, What information can simultaneous contrast give regarding the fundamental sensations of the colour-blind? From an extended series of observations Dr. Stilling,[1] of Cassel, has entertained that if a person cannot distinguish between red and green, no complementary colour appears in the shadow when the inducing light is red or green, but if the inducing light is yellow or blue the proper complementary appears in the shadow. If a person was blind to red he never found the complementary green appear; if he was blind to green, he never found the complementary red appear. When the inducing light appeared colourless, the shadow was also colourless. Stilling therefore concluded that either the sensations of red and green or of blue and yellow were wanting at the same time or all colour sense was absent. It is difficult to see how these results are to be harmonized with the conclusions arrived at by the Committee of the Royal Society.

Facts such as these are regarded by some as lending support to the theory of colour sense proposed by Prof. Hering, of Prague.[2] He supposes that the diversity of our visual perceptions arises from six fundamental sensations constituting three pairs—white and black, red and green, yellow and blue. The three pairs of sensations are supposed to arise from chemical changes in three visual substances not confined to the retina, but contained also in the optic nerve and in the vision centre.[3] He imagines that a sense of white results from *decomposition* induced in a special visual substance by all visible rays, and that the *restitution* of the same substance produces a sense of black. The sensations of the red and green pair are supposed to arise, the one from decomposition, the other from restitution of a second substance; while yellow and blue are supposed to result from decomposition and restitution of a third substance. From our knowledge of photo-chemical processes we can readily suppose that light induces chemical change in the visual apparatus; but that the wave-lengths in the red and yellow parts of the spectrum induce *decomposition*, while the wave-lengths in the green and blue induce *restitution* of substances, it is difficult to believe. How such a visual mechanism could work it would be difficult to comprehend; for example, if we look at a bright red light for a few moments and then close our eyes, the sensation remains for a time, but changes from red to green and then slowly fades away. According to Hering's theory, the green after-sensation results from the restitution of a substance decomposed by the red light. But if we reverse the experiment by looking at a bright *green* light and then closing our eyes, the after-sensation changes to *red*. The theory in question would require us to suppose that the green light builds up a visual substance which spontaneously decomposes when the eyes are closed, and so produces the red after-image. I confess that such a hypothesis seems to me incredible. Another remarkable feature of Hering's theory is that colours termed *complementary* ought to be termed *antagonistic*,[1] because they are capable of producing a colourless sensation when mingled in due proportions. If the complementary colours yellow and blue could, when mixed, produce black, they might well be named "antagonistic;" but since their combined effect is a sense of whiteness, and since the addition of them to white light increases its luminosity, it seems very difficult to comprehend on what ground the term *antagonistic* should be substituted for *complementary*. I confess I am quite unable to follow Hering when he supposes that three pairs of mutually antagonistic chemical processes are produced in the retina when white light falls on it, that these processes are all continued on through the optic nerve into the vision centre, and there give rise to our different light and colour sensations.

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[1] F. Holmgren, "How do the Colour-Blind see the Different Colours?" Proc. Roy. Soc. Lond., 1881, vol. xxxi. p. 306.

[2] See Reference 8, Plate I., No. 4.

[1] J. Stilling, "The Present Aspect of the Colour Question," *Archives of Ophthalmology*, 1879, viii. p. 164.

[2] E. Hering, *Zur Lehre vom Lichtsinne*, 2nd ed. Vienna, 1878.

[3] Hering, *ibid.*, p. 75.

In 1881 Prof. Preyer[2] advanced a theory of colour sensation, in which he supposes that in the retina there are four sets of cones arranged in pairs—one pair being excitable by the waves in the blue and yellow parts of the spectrum, the other pair being excitable by the red and green. He supposes that each pair of cones is connected with a ganglionic cell in the retina, and through that with one fibre in the optic nerve, which transmits the impulse to at least two cells in the vision centre, in which two different qualities of sensation, red and green, yellow and blue, are severally produced. I confess, however, that I am not able to understand how nerve impulses received, say, from the red terminal of a pair, can specially affect one of the cells in the nerve centre to produce a red sensation. But if the red or green sensation were supposed to arise in the same central cell according to the frequency of the impulses transmitted from either terminal of the pair at the periphery, I should feel that an important difficulty had been removed from Prof. Preyer's theory.

It must be admitted that the production of nerve impulses within the terminals in the retina is almost as obscure as ever. It is still the old question, Does light stimulate the optic terminals by inducing vibration, or by setting up chemical change? Whichever view we adopt, it seems to me necessary to suppose that all the processes for the production of nerve impulses can take place in one and the same visual cell, and are transmitted to the brain through the same nerve fibre; because the image of a coloured star small enough to fall upon only one cone is seen of a fixed and definite colour which does not alter when the position of the eye is changed. It seems to me that if there are special cones for red, green, yellow, and blue, the colour of the star should change when its image falls on different terminals, but I am assured by Mr. Lockyer that such is not the case.

I referred to the sense of smell because it seems to me that we cannot in that case escape from the conclusion that the different sensations arise from different molecular stimulations of the same olfactory terminals.

From Lippmann's recent researches on the photography of colour[3] it appears that all parts of the spectrum can now be photographed on films of albumino-bromide of silver, to which two aniline substances, azaline and cyanine, have been added. It seems, therefore, reasonable to suppose that a relatively small number of substances could enable all the rays of the visible spectrum to affect the retina. Helmholz believes that three visual substances would suffice; but if the primary sensations are to be regarded as four—red, green, yellow, and blue—at least four visual substances appear to be necessary; and I think we must assume that all of them are to be found in the same visual cell in the retina, and that the nerve impulses which their decompositions give rise to are all transmitted through the same optic fibres to the brain cells, there to produce a sense of uncoloured or coloured light. Evidently such a hypothesis is not altogether novel; it is essentially a return to that long ago suggested by Newton. The only difference is that light is supposed to induce photo-chemical changes in the retina, as Von Helmholz suggested, instead of mere mechanical vibration, as Newton supposed. But if in the sense of smell nerve undulations are induced by mechanical vibrations of molecules acting on delicate hairs at the ends of cells, would it, after all, be unreasonable to suppose that within each visual cell there are different kinds of molecules that vibrate in different modes when excited by ether-waves? Four or five sets of such molecules in each terminal element in the retina would probably be sufficient to project successively or simultaneously special forms of undulations through the optic nerve, to induce colour sensations differing according to the wave form of the incoming nerve undulation. It seems to me that the question becomes narrowed down to this: Do the nerve impulses arise from mere vibration or from chemical change in the molecules of the nerve terminal? The photo-chemical hypothesis has much in its favour. We know how rapidly light can induce chemical change in photographic films, and we know that light induces chemical change in the vision-purple in the outer segments of the rod cells in the retina. The fact that the cones contain no vision-purple is no argument against the theory, for the inner segment of both rod and cone is by many regarded as the true nerve terminal, and there is no vision-purple in either of them. The visual substances in the cones, at all events, are colourless, and the existence of them as substances capable of producing nerve impulses by chemical decomposition is as yet only a speculation awaiting proof. The fatigue of the retina produced by bright light is best explained on a chemical theory, but it could also be explained on a mechanical theory, for we must remember that, even if the nerve impulses produced in the visual cells were merely a translation of the energy of light into vibration of nerve molecules, the nerve impulse has to pass through layers of ganglionic cells before reaching the fibres of the optic nerve, and in these cells it probably always induces chemical change. The phenomena of partial colour-blindness could be explained on a photo-chemical theory by supposing that it arises from the absence of the substances required to produce the wave forms necessary for the colour sensation which is defective, but the total colour blindness at the anterior part of the retina is evidently a difficulty. How could we have a sense of light from that portion of the retina if all the visual substances are absent? That is one of the reasons why Hering supposed that a special visual substance is present everywhere in the retina, which by decomposition gives rise to a sense of light as distinguished from colour. But even on the hypothesis we are pursuing, it is not necessary to suppose that all visual substance is absent, for colour-blindness in the front of the retina could be explained by supposing that colour perception has not been developed in the corresponding portion of the vision centre, and consequently all nerve impulses coming from that part of the retina produce scarcely anything more than a sense of light.

If the photo-chemical theory is entertained, it seems necessary to suppose that there is some singular relation between the pairs of substances which respectively give rise to red and green, and yellow and blue, seeing that both members of a pair frequently, if not always, fail together.

It seems to me that the great difficulty arises when we consider the puzzling phenomena of contrast. If light of a particular wave length decomposes a special substance, and gives rise to, say, a sense of red, why does the complementary bluish-green sensation appear in the vision centre around the spot in which the red sensation arises? If the induced colour were a pure green, one might attempt to explain it by supposing that a sympathetic change had been induced in a substance closely related to that suffering decomposition by the objective light, but no such simple explanation is admissible; the complementary contrast of red is not green, but a mixture of green and blue. The inadmissibility of such an explanation becomes still more apparent if we take pure green as the inducing colour—the complementary contrast that appears is purple, which involves a blue or violet, as well as a red sensation. It matters not what inducing colour sensation we adopt, the induced contrast is always the complementary required to make a sense of white. George Wilson[1] long ago suggested that the simultaneous contrast probably arises from a "polar manifestation of force;" indeed, he regarded it as a "true, though unrecognized, manifestation of polarity." It is enough to mention that interesting suggestion, but I must not pursue it, for we are dealing with a problem that has as yet baffled the wit of man.

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[1] E. Hering, *Zur Lehre vom Lichtsinne*, 2nd ed. p. 121.

[2] W. Preyer, "Über den Fabren und Temperatur Sinn," &c., *Archiv für Physiologie*, 1881, Band xxv., p. 31

[3] G. Lippmann, "On the Photography of Colour," *Comptes Rendus*, 1892, tome 114, p. 961.

[1] Wilson, "Researches on Colour-Blindness," Edinburgh, 1855, p. 179.

I have endeavoured to place before you a subject that involves physical and physiological considerations of extreme difficulty. I have endeavoured to show the nature of these difficulties, and although I have not attempted to solve them, I have at all events tried to show reasons why we should refer our different colour sensations to differences in the incoming nerve impulses rather than to specifically different activities of cells in the visual centre. I have not found it an agreeable task to point out the shortcomings of theories advanced by those for whom I have the deepest regard; but in the progress of scientific thought it is especially necessary to keep our minds free from the thraldom of established theory, for theories are but the leaves of the tree of science; they bud and expand, and in time they fade and fall, but they enable the tree to breathe and live. If this address has been full of speculation, I trust you will allow that the scientific use of the imagination is a necessary stimulus to thought, by which alone we can break a path through the dense thicket of the unknown.

SECTION E.

GEOGRAPHY.

Opening Address by Prof. James Geikie, LL.D., D.C.L., F.R.SS.L. & E., F.G.S., President of the Section.

Amongst the many questions upon which of late years light has been thrown by deep-sea exploration and geological research not the least interesting is that of the geographical development of coast-lines. How is the existing distribution of land and water to be accounted for? Are the revolutions in the relative position of land and sea, to which the geological record bears witness, due to movements of the earth's crust or of the hydrosphere? Why are coast-lines in some regions extremely regular, while elsewhere they are much indented? About 150 years ago the prevalent belief was that ancient sea-margins indicated a formerly higher ocean-level. Such was the view held by Celsius, who, from an examination of the coast-lands of Sweden, attributed the retreat of the sea to a gradual drying up of the latter. But this desiccation hypothesis was not accepted by Playfair, who thought it much more likely that the land had risen. It was not, however, until after Von Buch had visited Sweden (1806–1808), and published the results of his observations, that Playfair's suggestion received much consideration. Von Buch concluded that the apparent retreat of the sea was not due to a general depression of the ocean-level, but to elevation of the land—a conclusion which subsequently obtained the strong support of Lyell. The authority of these celebrated men gained for the elevation theory more or less complete assent, and for many years it has been the orthodox belief of geologists that the ancient sea-margins of Sweden and other lands have resulted from vertical movements of the crust. It has long been admitted, however, that highly flexed and disturbed strata require some other explanation. Obviously such structures are the result of lateral compression and crumpling. Hence geologists have maintained that the mysterious subterranean forces have affected the crust in different ways. Mountain-ranges, they conceive, are ridged up by tangential thrusts and compression, while vast continental areas slowly rise and fall, with little or no disturbance of the strata. From this point of view it is the lithosphere that is unstable, all changes in the relative level of land and sea being due to crustal movements. Of late years, however, Trautschold and others have begun to doubt whether this theory is wholly true, and to maintain that the sea-level may have changed without reference to movements of the lithosphere. Thus Hilber has suggested that sinking of the sea-level may be due, in part at least, to absorption, while Schmick believes that the apparent elevation and depression of continental areas are really the results of grand secular movements of the ocean. The sea, according to him, periodically attains a high level in each hemisphere alternately, the waters being at present heaped up in the southern hemisphere. Prof. Suess, again, believing that in equatorial regions the sea is, upon the whole, gaining on the land, while in other latitudes the reverse would appear to be the case, points out that this is in harmony with his view of a periodical flux and reflux of the ocean between the equator and the poles. He thinks that we have no evidence of any vertical elevation affecting wide areas, and that the only movements of elevation that take place are those by which mountains are upheaved. The broad invasions and transgressions of the continental areas by the sea, which we know have occurred again and again, are attributed by him to secular movements of the hydrosphere itself.

Apart from all hypothesis and theory, we learn that the surface of the sea is not exactly spheroidal. It reaches a higher level on the borders of the continents than in mid-ocean, and it varies likewise in height at different places on the same coast. The attraction of the Himalaya, for example, suffices to cause a difference of 300 feet between the level of the sea at the delta of the Indus and on the coast of Ceylon. The recognition of such facts has led Penck to suggest that the submergence of the maritime regions of North-west Europe and the opposite coasts of North America, which took place at a recent geological date, and from which the lands in question have only partially recovered, may have been brought about by the attraction exerted by the vast ice-sheets of the Glacial Period. But, as Drygalski, Woodward, and others have shown, the heights at which recent marine deposits occur in the regions referred to are much too great to be accounted for by any possible distortion of the hydrosphere. The late James Croll had previously endeavoured to show that the accumulation of ice over northern lands during glacial times would suffice to displace the earth's centre of gravity, and thus cause the sea to rise upon the glaciated tracts. More recently other views have been advanced to explain the apparently causal connection between glaciation and submergence, but these need not be considered here.

Whatever degree of importance may attach to the various hypotheses of secular movements of the sea, it is obvious that the general trends of the world's coast-lines are determined in the first place by the position of the dominant wrinkles of the lithosphere. Even if we concede that all "raised beaches," so called, are not necessarily the result of earth-movements, and that the frequent transgressions of the continental areas by oceanic waters in geological times may possibly have been due to independent movements of the sea, still we must admit that the solid crust of the globe has always been subject to distortion. And this being so, we cannot doubt that the general trends of the world's coast-lines must have been modified from time to time by movements of the lithosphere.

As geographers we are not immediately concerned with the mode of origin of those vast wrinkles, nor need we speculate on the causes which may have determined their direction. It seems, however, to be the general opinion that the configuration of the lithosphere is due simply to the sinking in and crumpling up of the crust on the cooling and contracting nucleus. But it must be admitted that neither physicists nor geologists are prepared with a satisfactory hypothesis to account for the prominent trends of the great world-ridges and troughs. According to the late Prof. Alexander Winchell, these trends may have been the result of primitive tidal action. He was of opinion that the transmeridional progress of the tidal swell in early incrustive times on our planet would give the forming crust structural characteristics and aptitudes trending from north to south. The earliest wrinkles to come into existence, therefore, would be meridional or submeridional, and such, certainly, is the prevalent direction of the most conspicuous earth-features. There are many terrestrial trends, however, as Prof. Winchell knew, which do not conform to the requirements of his hypothesis; but such transmeridional features, he thought, could generally be shown to be of later origin than the others. This is the only speculation, so far as I know, which attempts, perhaps not altogether unsuccessfully, to explain the origin of the main trends of terrestrial features. According to other authorities, however, the area of the earth's crust occupied by the ocean is denser than that over which the continental regions are spread. The depressed denser part balances the lighter elevated portion. But why these regions of different densities should be so distributed no one has yet told us. Neither does Le Conte's view, that the continental areas and the oceanic depressions owe their origin to unequal radial contraction of the earth in its secular cooling, help us to understand why the larger features of the globe should be disposed as they are.

Geographers must for the present be content to take the world as they find it. What we do know is that our lands are distributed over the surface of a great continental plateau of irregular form, the bounding slopes of which plunge down more or less steeply into a vast oceanic depression. So far as geological research had gone, there is reason to believe that these elevated and depressed areas are of primeval antiquity—that they antedate the very oldest of the sedimentary formations. There is abundant evidence, however, to show that the relatively elevated or continental area has been again and again irregularly submerged under tolerably deep and wide seas. But all historical geology assures us that the continental plateau and the oceanic hollows have never changed places, although from time to time portions of the latter have been ridged up and added to the margins of the former, while ever and anon marginal portions of the plateau have sunk down to very considerable depths. We may thus speak of the great world-ridges as regions of dominant elevation, and of the profound oceanic troughs as areas of more or less persistent depression. From one point of view, it is true, no part of the earth's surface can be looked upon as a region of dominant elevation. Our globe is a cooling and contracting body, and depression must always be the prevailing movement of the lithosphere. The elevation of the continental plateau is thus only relative. Could we conceive the crust throughout the deeper portions of the oceanic depression to subside to still greater depths, while at the same time the continental plateau remained stationary, or subsided more slowly, the sea would necessarily retreat from the land, and the latter would then appear to rise. It is improbable, however, that any extensive subsidence of the crust under the ocean could take place without accompanying disturbance of the continental plateau; and in this case the latter might experience in places not only negative but positive elevation. During the evolution of our continent, crustal movements have again and again disturbed the relative level of land and sea, but since the general result has been to increase the land surface and to contract the area occupied by the sea, it is convenient to speak of the former as the region of dominant elevation, and of the latter as that of prevalent depression. Properly speaking, both are sinking regions, the rate of subsidence within the oceanic trough being in excess of that experienced over the continental plateau. The question of the geographical development of coast-lines is therefore only that of the dry lands themselves.

The greater land masses are all situated upon, but are nowhere coextensive with, the area of dominant elevation, for very considerable portions of the continental plateau are still covered by the sea. Opinions may differ as to which fathoms line we should take as marking approximately the boundary between that region and the oceanic depression; and it is obvious, indeed, that any line selected must be arbitrary and more or less misleading, for it is quite certain that the true boundary of the continental plateau cannot lie parallel to the surface of the ocean. In some regions it approaches within a few hundreds of fathoms of the sea-level; in other places it sinks for considerably more than 1000 fathoms below that level. Thus, while a very moderate elevation would in certain latitudes cause the land to extend to the edge of the plateau, an elevation of at least 10,000 feet would be required in some other places to bring about a similar result.

Although it is true that the land surface is nowhere coextensive with the great plateau, yet the existing coast-lines may be said to trend in the same general direction as its margins. So abruptly does the continental plateau rise from the oceanic trough, that a depression of the sea-level, or an elevation of the plateau, for 10,000 feet, would add only a narrow belt to the Pacific coast between Alaska and Cape Horn, while the gain of land on the Atlantic slope of America between 30° N.L. and 40° S.L. would not be much greater. In the higher latitudes of the Northern Hemisphere, however, very considerable geographical changes would be accomplished by a much less amount of elevation of the plateau. Were the continental plateau to be upheaved for 3000 feet, the major portion of the Arctic Sea would become land. Thus, in general terms, we may say that the coast-lines of Arctic and temperate North America and Eurasia are further withdrawn from the edge of the continental plateau than those of lower latitudes.

In regions where existing coast-lines approach the margin of the plateau, they are apt to run for long distances in one determinate direction, and whether the coastal area be high or not, to show a gentle sinuosity. Their course is seldom interrupted by bold projecting headlands or peninsulas, or by intruding inlets, while fringing or marginal islands rarely occur. To these appearances the northern regions, as every one knows, offer the strongest contrast. Not only do they trend irregularly, but their continuity is constantly interrupted by promontories and peninsulas, by inlets and fords, while fringing islands abound. But an elevation of some 400 or 500 fathoms only would revolutionize the geography of those regions, and confer upon the northern coast-lines of the world the regularity which at present characterizes those of Western Africa.

It is obvious, therefore, that the coast-lines of such lands as Africa owe their regularity primarily to their approximate coincidence with the steep boundary slopes of the continental plateau, while the irregularities characteristic of the coast-line of North-Western Europe and the corresponding latitudes of North America are determined by the superficial configuration of the same plateau, which in those regions is relatively more depressed. I have spoken of the general contrast between high and low northern latitudes, but it is needless to say that in southern regions the coast-lines exhibit similar contrasts. The regular coast-lines of Africa and South America have already been referred to, but we cannot fail to recognize in the much indented sea-board and the numerous coastal island of Southern Chili a complete analogy to the fiord regions of high northern latitudes. Both are areas of comparatively recent depression. Again, the manifold irregularities of the coasts of South-eastern Asia, and the multitudes of islands that serve to to link that continent to Australia and New Zealand, are all evidence that the surface of the continental plateau in those regions is extensively invaded by the sea.

A word or two now as to the configuration of the oceanic trough. There can be no doubt that this differs very considerably from that of the land surface. It is, upon the whole, flat or gently undulating. Here and there it swells gently upwards into broad elevated banks, some of which have been traced for great distances. In other places narrower ridges and abrupt mountain-like elevations diversify its surface, and project again and again above the level of the sea, to form the numerous islets of Oceania. Once more, the sounding-line has made us acquainted with the notable fact that numerous deep depressions—some long and narrow, others relatively short and broad—stud the floor of the great trough. I shall have occasion to refer again to these remarkable depressions, and need at present only call attention to the fact that they are especially well developed in the region of the Western Pacific, where the floor of the sea, at the base of the bounding slopes of the continental plateau, sinks in places to depths of three and even of five miles below the existing coast-lines. One may further note the fact that the deepest areas of the Atlantic are met with in like manner close to the walls of the plateau—a long ridge, which rises midway between the continents and runs in the same general direction as their coast-lines, serving to divide the trough of the Atlantic into two parallel hollows.

But, to return to our coast-lines and the question of their development, it is obvious that their general trends have been determined by crustal movements. Their regularity is in direct proportion to the closeness of their approach to the margin of the continental plateau. The more nearly they coincide with the edge of that plateau, the fewer irregularities do they present; the further they recede from it, the more highly are they indented. Various other factors, it is true, have played a more or less important part in their development, but their dominant trends were undoubtedly determined at a very early period in the world's history—their determination necessarily dates back, in short, to the time when the great world-ridges and oceanic troughs came into existence. So far as we can read the story told by the rocks, however, it would seem that in the earliest ages of which geology can speak with any confidence, the coast-lines of the world must have been infinitely more irregular than now. In Palæozoic times, relatively small areas of the continental plateau appeared above the level of the sea. Insular conditions everywhere prevailed. But as ages rolled on wider and wider tracts of the plateau were exposed, and this notwithstanding many oscillations of level. So that one may say there has been upon the whole a general advance from insular to continental conditions. In other words, the sea has continued to retreat from the surface of the continental plateau. To account for this change we must suppose that depression of the crust has been in excess within the oceanic area, and that now and again positive elevation of the continental plateau has taken place, more especially along its margins. That movements of elevation, positive or negative, have again and again affected our land areas can be demonstrated, and it seems highly probable, therefore, that similar movements may have been experienced with the oceanic trough.

Two kinds of crustal movement, as we have seen, are recognized by geologists. Sometimes the crust appears to rise, or, as the case may be, to sink over wide regions, without much disturbance or tilting of strata, although these are now and again more or less extensively fractured and displaced. It may conduce to clearness if we speak of these movements as regional. The other kind of crustal disturbance takes place more markedly in linear directions, and is always accompanied by abrupt folding and mashing together of strata, along with more or less fracturing and displacement. The plateau of the Colorado has often been cited as a good example of regional elevation, where we have a wide area of approximately horizontal strata apparently uplifted without much rock-disturbance, while the Alps or any other chain of highly flexed and convoluted strata will serve as an example of what we may term axial or linear uplifts. It must be understood that both regional and axial movements result from the same cause—the adjustment of the solid crust to the contracting nucleus—and that the term *elevation*, therefore, is only relative. Sometimes the sinking crust gets relief from the enormous lateral pressure to which it is subjected by ridging up along lines of weakness, and then mountains of elevation are formed; at other times, the pressure is relieved by the formation of broader swellings, when wide areas become uplifted relatively to surrounding regions. Geologists, however, are beginning to doubt whether upheaval of the latter kind can affect a broad continental area. Probably in most cases, the apparent elevation of continental regions is only negative. The land appears to have risen because the floor of the oceanic basin has become depressed. Even the smaller plateau-like elevations which occur within some continental regions may in a similar way owe their dominance to the sinking of contiguous regions.

In the geographical development of our land, movements of elevation and depression have played an important part. But we cannot ignore the work done by other agents of change. If the orographical features of the land everywhere attest the potency of plutonic agents, they no less forcibly assure us that the inequalities of surface resulting from such movement are universally modified by denudation and sedimentation. Elevated plains and mountains are gradually demolished, and the hollows and depressions of the great continental plateau become slowly filled with their detritus. Thus inland seas tend to vanish, inlets and estuaries are silted up, and the land in places advances seaward. The energies of the sea, again, come in to aid those of rain and river, so that under the combined action of all the superficial agents of change, the irregularities of coast-lines become reduced, and, were no crustal movement to intervene, would eventually disappear. The work accomplished by those agents upon a coast-line is most conspicuous in regions where the surface of the continental plateau is occupied by comparatively shallow seas. Here full play is given to sedimentation and marine erosion, while the latter alone comes into prominence upon shores that are washed by deeper waters. When the coast-lines advance to the edge of the continental plateau, they naturally trend, as we have seen, for great distances in some particular direction. Should they preserve that position, undisturbed by crustal oscillation, for a prolonged period of time, they will eventually be cut back by the sea. In this way a shelf or terrace will be formed, narrow in some places, broader in others, according to the resistance offered by the varying character of the rocks. But no long inlets or fiords can result from such action. At most the harder and less readily demolished rocks will form headlands, while shallow bays will be scooped out of the more yielding masses. In short, between the narrower and broader parts of the eroded shelf or terrace a certain proportion will tend to be preserved. As the shelf is widened, sedimentation will become more and more effective, and in places may come to protect the land from further marine erosion. This action is especially conspicuous in tropical and subtropical regions, which are characterized by well-marked rainy seasons. In such regions immense quantities of sediment are washed down from the land to the sea, and tend to accumulate along shore, forming low alluvial flats. All long-established coast-lines thus acquire a characteristically sinuous form, and perhaps no better examples could be cited than those of Western Africa.

To sum up, then, we may say that the chief agents concerned in the development of coast-lines are crustal movements, sedimentation, and marine erosion. All the main trends are the result of elevation and depression. Considerable geographical changes, however, have been brought about by the silting up of those shallow and sheltered seas which, in certain regions, overflow wide areas of the continental plateau. Throughout all the ages, indeed, epigene agents have striven to reduce the superficial inequalities of that plateau, by levelling heights and filling up depressions, and thus, as it were, flattening out the land surface and causing it to extend. The erosive action of the sea, from our present point of view, is of comparatively little importance. It merely adds a few finishing touches to the work performed by the other agents of change.

A glance at the geographical evolution of our own continent will render this sufficiently evident. Viewed in detail, the structure of Europe is exceedingly complicated, but there are certain leading features in its architecture which no profound analysis is required to detect. We note, in the first place, that highly disturbed rocks of Archæan and Palæozoic age reach their greatest development along the north-western and western borders of our continent, as in Scandinavia, the British Islands, North-west France, and the Iberian peninsula. Another belt of similarly disturbed strata of like age traverses Central Europe from west to east, and is seen in the South of Ireland, Cornwall, North-west France, the Ardennes, the Thüringerwald, the Erzgebirge, the Riesengebirge, the Böhmerwald, and other heights of Middle and Southern Germany. Strata of Mesozoic and Cainozoic age rest upon the older systems in such a way as to show that the latter had been much folded, fractured, and denuded before they came to be covered with younger formations. North and north-east of the central belt of ancient rocks just referred to, the sedimentary strata that extend to the shores of the Baltic and over a vast region in Russia, range in age from Palæozoic down to Cainozoic times, and are disposed for the most part in gentle undulations—they are either approximately horizontal or slightly inclined. Unlike the disturbed rocks of the maritime regions and of Central Europe, they have obviously been subjected to comparatively little folding since the time of their deposition. To the south of the primitive backbone of Central Europe succeeds a region composed superficially of Mesozoic and Cainozoic strata for the most part, which, along with underlying Palæozoic and Archæan rocks, are often highly flexed and ridged up, as in the chains of the Jura, the Alps, the Carpathians, &c. One may say, in general terms, that throughout the whole Mediterranean area Archæan and Palæozoic rocks appear at the surface only when they form the nuclei of mountains of elevation into the composition of which rocks of younger age largely enter.

From this bald and meagre outline of the general geological structure of Europe, we may gather that the leading orographical features of our continent began to be developed at a very early period. Unquestionably the oldest land areas are represented by the disturbed Archæan and Palæozoic rocks of the Atlantic sea-board and Central Europe. Examination of those tracts shows that they have experienced excessive denudation. The Archæan and Palæozoic masses, distributed along the margin of the Atlantic, are the mere wrecks of what, in earlier ages, must have been lofty regions, the mountain-chains of which may well have rivalled or even exceeded in height the Alps of to-day. They, together with the old disturbed rocks of Central Europe, formed for a long time the only land in our area. Between the ancient Scandinavian tract in the north and a narrow interrupted belt in Central Europe stretched a shallow sea, which covered all the regions that now form our Great Plain; while immediately south of the central belt lay the wide depression of the Mediterranean—for as yet the Pyrenees, the Alps, and the Carpathians were not. Both the Mediterranean and the Russo-Germanic sea communicated with the Atlantic. As time went on, land continued to be developed along the same lines, a result due partly to crustal movements, partly to sedimentation. Thus by and by the relatively shallow Russo-Germanic sea became silted up, while the Mediterranean shore-line advanced southwards. It is interesting to note that the latter sea, down to the close of Tertiary times, seems always to have communicated freely with the Atlantic, and to have been relatively deep. The Russo-Germanic sea, on the contrary, while now and again opening widely into the Atlantic, and attaining considerable depths in its western reaches, remained on the whole shallow, and ever and anon vanished from wide areas to contract into a series of inland seas and large salt lakes.

Reduced to its simplest elements, therefore, the structure of Europe shows two primitive ridges—one extending with some interruptions along the Atlantic sea-board, the other traversing Central Europe from west to east, and separating the area of the Great Plain from the Mediterranean basin. The excessive denudation which the more ancient lands have undergone, and great uplifts of Mesozoic and of Cainozoic times, together with the comparatively recent submergence of broad tracts in the north and north-west, have not succeeded in obscuring the dominant features in the architecture of our continent.

I now proceed to trace, as rapidly as I can, the geographical development of the coast-lines of the Atlantic as a whole, and to point out the chief contrasts between them and those of the Pacific. The extreme irregularity of the Arctic and Atlantic shores of Europe at once suggests to a geologist a partially drowned land, the superficial inequalities of which are accountable for the vagaries of the coast-lines. The fiords of Norway and Scotland occupy what were at no distant date land valleys, and the numerous marginal islands of those regions are merely the projecting portions of a recently sunken area. The continental plateau extends up to and a little beyond the one hundred fathoms line, and there are many indications that the land formerly reached as far. Thus the sunken area is traversed by valley-like depressions, which widen as they pass out to the edge of the plateau, and have all the appearance of being hollows of subaerial erosion. I have already mentioned the fact that the Scandinavian uplands and the Scottish Highlands are the relics of what were at one time true mountains of elevation, corresponding in the mode of their formation to those of Switzerland, and, like these, attaining a great elevation. During subsequent stages of Palæozoic time, that highly elevated region was subjected to long-continued and profound erosion—the mountain country was planed down over wide regions to sea-level, and broad stretches of the reduced land surface became submerged. Younger Palæozoic formations now accumulated upon the drowned land, until eventually renewed crustal disturbance supervened, and the marginal areas of the continental plateau again appeared as dry land, but not, as before, in the form of mountains of elevation. Lofty table-lands now took the place of abrupt and serrated ranges and chains—table-lands which, in their turn, were destined in the course of long ages to be deeply sculptured and furrowed by subaerial agents. During this process the European coast-line would seem to have coincided more or less closely with the edge of the continental plateau. Finally, after many subsequent movements of the crust in these latitudes, the land became partially submerged—a condition from which North-western and Northern [Europe would appear in recent times to be slowly recovering. Thus the highly indented coast-line of those regions does not coincide with the edge of the plateau, but with those irregularities of its upper surface which are the result of antecedent subaerial erosion.

Mention has been made of the Russo-Germanic plain and the Mediterranean as representing original depressions in the continental plateau, and of the high grounds that extend between them as regions of dominant elevation, which, throughout all the manifold revolutions of the past, would appear to have persisted as a more or less well-marked boundary, separating the northern from the southern basin. During certain periods it was no doubt in some degree submerged, but never apparently to the same extent as the depressed areas it served to separate. From time to time uplifts continued to take place along this central belt, which thus increased in breadth, the younger formations, which were accumulated along the margins of the two basins, being successively ridged up against nuclei of older rocks. The latest great crustal movements in our continent, resulting in the uplift of the Alps and other east and west ranges of similar age, have still further widened that ancient belt of dominant elevation which in our day forms the most marked orographical feature of Europe.

The Russo-Germanic basin is now for the most part land, the Baltic and the North Sea representing its still submerged portions. This basin, as already remarked, was probably never so deep as that of the Mediterranean. We gather as much from the fact that, while mechanical sediments of comparatively shallow-water origin predominate in the former area, limestones are the characteristic features of the southern region. Its relative shallowness helps us to understand why the northern depression should have been silted up more completely than the Mediterranean. We must remember also that for long ages it received the drainage of a much more extensive land surface than the latter—the land that sloped towards the Mediterranean in Palæozoic and Mesozoic times being of relatively little importance. Thus the crustal movements which ever and anon depressed the Russo-Germanic area were, in the long run, counterbalanced by sedimentation. The uplift of the Alps, the Atlas, and other east and west ranges, has greatly contracted the area of the Mediterranean, and sedimentation has also acted in the same direction, but it is highly probable that that sea is now as deep as, or even deeper than, it has ever been. It occupies a primitive depression in which the rate of subsidence has exceeded that of sedimentation. In many respects, indeed, this remarkable transmeridional hollow—continued eastward in the Red Sea, the Black Sea, and the Aralo-Caspian depression—is analogous, as we shall see, to the great oceanic trough itself.

In the earlier geological periods linear or axial uplifts and volcanic action again and again marked the growth of the land on the Atlantic sea-board. But after Palæozoic times, no great mountains of elevation came into existence in that region, while volcanic action almost ceased. In Tertiary times, it is true, there was a remarkable recrudescence of volcanic activity, but the massive eruptions of Antrim and Western Scotland, of the Færöe Islands and Iceland, must be considered apart from the general geology of our continent. From Mesozoic times onwards it was along the borders of the Mediterranean depression that great mountain uplifts and volcanoes chiefly presented themselves. And as the land surface extended southwards from Central Europe, and the area of the Mediterranean was contracted, volcanic action followed the advancing shore-lines. The occurrence of numerous extinct and of still existing volcanoes along the borders of this inland sea, the evidence of recent crustal movements so commonly met with upon its margins, the great irregularities of its depths, the proximity of vast axial uplifts of late geological age, and the frequency of earthquake phenomena, all indicate instability, and remind us strongly of similarly constructed and disturbed regions within the area of the vast Pacific.

Let us now look at the Arctic and Antarctic coast-lines of North America. From the extreme north down to the latitude of New York the shores are obviously those of a partially submerged region. They are of the same type as the coasts of North-western Europe. We have every reason to believe also that the depression of Greenland and North-east America, from which these lands have only partially recovered, dates back to a comparatively recent period. The fiords, and inlets, like those of Europe, are merely half-drowned land valleys, and the continental shelf is crossed by deep hollows which are evidently only the seaward continuations of well-marked terrestrial features. Such, for example, is the case with the valleys of the Hudson and the St. Lawrence, the submerged portions of which can be followed out to the edge of the continental plateau, which is notched by them at depths of 474 and 622 fathoms respectively. There is, in short, a broad resemblance between the coasts of the entire Arctic and North Atlantic regions down to the latitudes already mentioned. Everywhere they are irregular and fringed with islands in less or greater abundance—highly denuded and deeply incised plateaus being penetrated by fiords, while low-lying and undulating lands that shelve gently seaward are invaded by shallow bays and inlets. Comparing the American with the opposite European coasts, one cannot help being struck with certain other resemblances. Thus Hudson Bay at once suggests the Baltic, and the Gulf of Mexico, with the Caribbean Sea, recall the Mediterranean. But the geological structure of the coast-lands of Greenland and North America betrays a much closer resemblance between these and the opposite shores of Europe than appears on a glance at the map. There is something more than a mere superficial similarity. In eastern North America and Greenland, just as in Western Europe, no grand mountain uplifts have taken place for a prodigious time. The latest great upheavals, which were accompanied by much folding and flexing of strata, are those of the Appalachian chain and of the coastal ranges extending through New England, Nova Scotia, and Newfoundland, all of which are of Palæozoic age. Considerable crustal movements affected the American coast-lands in Mesozoic times, and during these uplifts the strata suffered fracture and displacement, but were subjected to comparatively little folding. Again, along the maritime borders of North-east America, as in the corresponding coast-lands of Europe, igneous action, more or less abundant in Palæozoic and early Mesozoic times, has since been quiescent. From the mouth of the Hudson to the Straits of Florida the coast-lands are composed of Tertiary and Quaternary deposits. This shows that the land has continued down to recent times to gain upon the sea—a result brought about partly by quiet crustal movements, but to a large extent by sedimentation, aided, on the coasts of Florida, by the action of reef-building corals.

Although volcanic action has long ceased on the American sea-board, we note that in Greenland, as in the West of Scotland and North of Ireland, there is abundant evidence of volcanic activity at so late a period as the Tertiary. It would appear that the great plateau-basalts of those regions, and of Iceland and the Færöe Islands, were contemporaneous, and possibly connected with an important crustal movement. It has long been suggested that at a very early geological period Europe and North America may have been united. The great thickness attained by the Palæozoic rocks in the eastern areas of the latter implies the existence of a wide land surface from which ancient sediments were derived. That old land must have extended beyond the existing coast-line, but how far we cannot tell. Similarly in North-west Europe, during early Palæozoic times, the land probably stretched further into the Atlantic than at present. But whether, as some think, an actual land connection subsisted between the two continents it is impossible to say. Some such connection was formerly supposed necessary to account for the emigration and immigration of certain marine forms of life which are common to the Palæozoic strata of both continents, and which, as they were probably denizens of comparatively shallow water, could only have crossed from one area to another along a shore-line. It is obvious, indeed, that if the oceanic troughs in those early days were of an abysmal character, a land bridge would be required to explain the geographical distribution of cosmopolitan life-forms. But if it be true that subsidence of the crust has been going on through all geological time, and that the land areas have notwithstanding continued to extend over the continental plateau, then it follows that the oceanic trough must be deeper now than it was in Palæozoic times. There are, moreover, certain geological facts which seem hardly explicable on the assumption that the seas of past ages attained abysmal depths over any extensive areas. The Palæozoic strata which enter so largely into the framework of our lands have much the same appearance all the world over, and were accumulated for the most part in comparatively shallow water. A petrographical description of the Palæozoic mechanical sediments of Europe would serve almost equally well for those of America, of Asia, or of Australia. Take in connection with this the fact that Palæozoic faunas had a very much wider range than those of Mesozoic and later ages, and were characterized above all by the presence of many cosmopolitan species, and we can hardly resist the conclusion that it was the comparative shallowness of the ancient seas that favoured that wide dispersal of species, and enabled currents to distribute sediments the same in kind over such vast regions. As the oceanic area deepened and contracted, and the land surface increased, marine faunas were gradually restricted in their range, and cosmopolitan marine faunas diminished in numbers, while sediments, gathering in separate regions, became more and more differentiated. For these and other reasons, which need not be entered upon here, I see no necessity for supposing that a Palæozoic Atlantis connected Europe with North America. The broad ridge upon which the Færöe Islands and Iceland are founded, seems to pertain as truly to the oceanic depression as the long Dolphin Ridge of the South Atlantic. The trend of the continental plateau in high latitudes is shown, as I think, by the general direction of the coast-lines of North-Western Europe and East Greenland, the continental shelf being submerged in those regions for a few hundred fathoms only. How the Icelandic ridge came into existence, and what its age may be, we can only conjecture. It may be a wrinkle as old as the oceanic trough which it traverses, or its origin may date back to a much more recent period. We may conceive it to be an area which has subsided more slowly than the floor of the ocean to the north and south; or, on the other hand, it may be a belt of positive elevation. Perhaps the latter is the more probable supposition, for it seems very unlikely that crustal disturbances, resulting in axial and regional uplifts, should have been confined to the continental plateau only. Be that as it may, there seems little doubt that land connection did obtain between Greenland and Europe in Cainozoic times, along this Icelandic ridge, for relics of the same Tertiary flora are found in Scotland, the Færöe Islands, Iceland, and Greenland. The deposits in which these plant-remains occur are associated with great sheets of volcanic rocks which in the Færöe Islands and Iceland reach a thickness of many thousand feet. Of the same age are the massive basalts of Jan Mayen, Spitzbergen, Franz Joseph Land, and Greenland. These lavas seem seldom to have issued from isolated foci in the manner of modern eruptions, but rather to have welled up along the lines of rectilineal fissures. From the analogy of similar phenomena in other parts of the world it might be inferred that the volcanic action of these northern regions may have been connected with a movement of elevation, and that the Icelandic ridge, if it did not come into existence during the Tertiary period, was at all events greatly upheaved at that time. It would seem most likely, in short, that the volcanic action in question was connected mainly with crustal movements in the oceanic trough. Similar phenomena, as is well known, are met with further south in the trough of the Atlantic. Thus the volcanic Azores rise like Iceland from the surface of a broad ridge which is separated from the continental plateau by wide and deep depressions. And so again, from the back of the great Dolphin Ridge, spring the volcanic islets of St. Paul's, Ascension, and Tristan d'Acunha.

I have treated of the Icelandic bank at some length for the purpose of showing that its volcanic phenomena do not really form an exception to the rule that such eruptions ceased after Palæozoic or early Mesozoic times to disturb the Atlantic coast-lines of Europe and North America. As the bank in question extends between Greenland and the British Islands, it was only natural that both those regions should be affected by its movements. But its history pertains essentially to that of the Atlantic trough; and it seems to show how transmeridional movements of the crust, accompanied by vast discharges of igneous rock, may come in time to form land connections between what are now widely separated areas.

Let us next turn our attention to the coast-lines of the Gulf of Mexico and the Caribbean Sea. These enclosed seas have frequently been compared to the Mediterranean, and the resemblance is self-evident. Indeed, it is so close that one may say the Mexican-Caribbean Sea and the Mediterranean are rather homologous than simply analogous. The latter, as we have seen, occupies a primitive depression, and formerly covered a much wider area. It extended at one time over much of Southern Europe and Northern Africa, and appears to have had full communication across Asia Minor with the Indian Ocean, and with the Arctic Ocean athwart the low-lying tracts of North-Western Asia. Similarly, it would seem, the Mexican-Caribbean Sea is the remaining portion of an ancient inland sea which formerly stretched north through the heart of North America to the Arctic Ocean. Like its European parallel, it has been diminished by sedimentation and crustal movements. It resembles the latter also in the greatness and irregularity of its depths, and in the evidence which its islands supply of volcanic action as well as of very considerable crustal movements within geological times. Along the whole northern borders of the Gulf of Mexico the coast-lands, like those on the Atlantic seaboard of the Southern States, are composed of Tertiary and recent accumulations, and the same is the case with Yucatan; while similar young formations are met with on the borders of the Caribbean Sea and the Antilles. The Bahamas and the Windward Islands mark out for us the margin of the continental plateau, which here falls away abruptly to profound depths. One feels assured that this portion of the plateau has been ridged up to its present level at no distant geological date. But notwithstanding all the evidence of recent extensive crustal movements in this region, it is obvious that the Mexican-Caribbean depression, however much it may have been subsequently modified, is of primitive origin.[1]

Before we leave the coast-lands of North America, I would again point out their leading geological features. In a word, then, they are composed for the most part of Archæan and Palæozoic rocks; no great linear or axial uplifts marked by much flexure of strata have taken place in those regions since Palæozoic times; while igneous action virtually ceased about the close of the Palæozoic or the commencement of the Mesozoic period. It is not before we reach the shores of the Southern States and the coast-lands of the Mexican-Caribbean Sea that we encounter notable accumulations of Mesozoic, Tertiary, and younger age. These occur in approximately horizontal positions round the Gulf of Mexico, but in the Sierra Nevada or Northern Colombia and the Cordilleras of Venezuela Tertiary strata are ridged up into true mountains of elevation. Thus the Mexican-Caribbean depression, like that of the Mediterranean, is characterized not only by its irregular depths and its volcanic phenomena, but by the propinquity of recent mountains of upheaval, which bear the same relation to the Caribbean Sea that the mountains of North Africa do to the Mediterranean.

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[1] Professor Suess thinks it is probable that the Caribbean Sea and the Mediterranean are portions of one and the same primitive depression which traversed the Atlantic area in early Cretaceous times. He further suggests that it may have been through the gradual widening of this central Mediterranean that the Atlantic in later times came into existence.

We may now compare the Atlantic coasts of South America with those of Africa. The former coincide in general direction with the edge of the continental plateau, to which they closely approach between Cape St. Roque and Cape Frio. In the north-east, between Cape Paria, opposite Trinidad, and Cape St. Roque, the continental shelf attains a considerably greater breadth, while south of Cape Frio it gradually widens, until, in the extreme south, it runs out towards the east in the form of a narrow ridge, upon the top of which rise the Falkland Islands and South Georgia. Excluding from consideration for the present all recent alluvial and Tertiary deposits, we may say that the coast lands from Venezuela down to the South of Brazil are composed principally of Archæan rocks; the eastern borders of the continent further south being formed of Quaternary and Tertiary accumulations. So far as we know, igneous rocks are of rare occurrence on the Atlantic sea-board. Palæozoic strata approach the coast-lands at various points between the mouths of the Amazons and La Plata, and these, with the underlying and surrounding Archæan rocks, are more or less folded and disturbed, while the younger strata of Mesozoic and Cainozoic age (occupying wide regions in the basin of of the Amazons, and here and there fringing the sea-coast), occur in approximately horizontal positions. It would appear, therefore, that no great axial uplifts have taken place in those regions since Palæozoic times. The crustal movements of later ages were regional rather than axial; the younger rocks are not flexed and mashed together, and their elevation (negative or positive) does not seem to have been accompanied by conspicuous volcanic action.

The varying width of the continental shelf is due to several causes. The Orinoco, the Amazons, and other rivers descending to the north-west coast, carry enormous quantities of sediment, much of which comes to rest on the submerged slopes of the continental plateau, so that the continental shelf tends to extend seawards. The same process takes place on the south-east coast, where the River Plate discharges its muddy waters. South of latitude 40° S., however, another cause has come into play. From the mouth of the Rio Negro to the terminal point of the continent the whole character of the coast betokens a geologically recent emergence, accompanied and followed by considerable marine erosion. So that in this region the continental shelf increases in width by the retreat of the coast-line, while in the north-east it gains by advancing seawards. It is to be noted, however, that even there, in places where the shores are formed of alluvia, the sea tends to encroach upon the land.

The Atlantic coast of Africa resembles that of South America in certain respects, but it also offers some important contrasts. As the northern coasts of Venezuela and Colombia must be considered in relation rather to the Caribbean depression than to the Atlantic, so the African sea-board between Cape Spartel and Cape Nun pertains structurally to the Mediterranean region. From the southern limits of Morocco to Cape Colony the coastal heights are composed chiefly of Archæan and Palæozoic rocks, the low shore-lands showing here and there strata of Mesozoic and Tertiary age together with still more recent deposits. The existing coast-lines everywhere advance close to the edge of the continental plateau, so that the submarine shelf is relatively narrower than that of Eastern South America. The African coast is still further distinguished from that of South America by the presence of several groups of volcanic islands—Fernando Po and others in the Gulf of Guinea, and Cape Verde and Canary Islands. The last-named group, however, notwithstanding its geographical position, is probably related rather to the Mediterranean depression than to the Atlantic trough.

The geological structure of the African coast-lands shows that the earliest to come into existence were those that extend between Cape Nun and the Cape of Good Hope. The coastal ranges of that section are much denuded, for they are of very great antiquity, having been ridged up in Palæozoic times. The later uplifts (negative or positive) of the same region were not attended by tilting and folding of strata, for the Mesozoic and Tertiary deposits, like those of South America, lie in comparatively horizontal positions. Between Cape Nun and Cape Spartel the rocks of the maritime tracts range in age from Palæozoic to Cainozoic, and have been traced across Morocco into Algeria and Tunis. They all belong to the Mediterranean region, and were deposited at a time when the southern shores of that inland sea extended from a point opposite the Canary Islands along the southern margin of Morocco, Algeria, and Tunis. Towards the close of the Tertiary period the final upheaval of the Atlas took place, and the Mediterranean, retreating northwards, became an almost land-locked sea.

I need hardly stop to point out how the African coast-lines have been modified by marine erosion and the accumulation of sediment upon the continental shelf. The extreme regularity of the coasts is due partly to the fact that the land is nearly coextensive with the continental plateau, but it also results in large measure from the extreme antiquity of the land itself. This has allowed of the cutting-back of headlands and the filling-up of bays and inlets, a process which has been going on between Morocco and Cape Colony with probably little interruption for a very prolonged period of time. We may note also the effect of the heavy rains of the equatorial region in washing down detritus to the shores, and in this way protecting the land to some extent from the erosive action of the sea.

What now, let us ask, are the outstanding features of the coast-lines of the Atlantic Ocean? We have seen that along the margins of each of the bordering continents the last series of great mountain-uplifts took place in Palæozoic times. This is true alike for North and South America, for Europe and Africa. Later movements which have added to the extent of land were not marked by the extreme folding of strata which attended the early upheavals. The Mesozoic and Cainozoic rocks, which now and again form the shore-lands, occur in more or less undisturbed condition. The only great linear uplifts or true mountains of elevation which have come into existence in Western Europe and Northern Africa since the Palæozoic period trend approximately at right angles to the direction of the Atlantic trough, and are obviously related to the primitive depression of the Mediterranean. The Pyrenees and the Atlas, therefore, although their latest elevation took place in Tertiary times, form no exceptions to the rule that the extreme flexing and folding of strata which is so conspicuous a feature in the geological structure of the Atlantic sea-board dates back to the Palæozoic era. And the same holds true of North and South America. There all the coastal ranges of highly flexed and folded strata are of Palæozoic age. The Cordilleras of Venezuela are no doubt a Tertiary uplift, but they are as obviously related to the Caribbean depression as the Atlas ranges are to that of the Mediterranean. Again, we note that volcanic activity along the borders of the Atlantic was much less pronounced during the Mesozoic period than it appears to have been in earlier ages. Indeed, if we except the great Tertiary basalt-flows of the Icelandic ridge and the Arctic regions, we may say that volcanic action almost ceased after the Palæozoic era to manifest itself upon the Atlantic coast-lands of North America and Europe. But while volcanic action has died out upon the Atlantic margins of both continents, it has continued during a prolonged geological period within the area of the Mediterranean depression. And in like manner the corresponding depression between North and South America has been the scene of volcanic disturbances from Mesozoic down to recent times. Along the African coasts the only displays of recent volcanic action that appertain to the continental margin are those of the Gulf of Guinea and the Cape de Verde Islands. The Canary Islands and Madeira may come under the same category, but, as we have seen, they appear to stand in relationship to the Mediterranean depression and the Tertiary uplift of North Africa. Of Iceland and the Azores I have already spoken, and of Ascension and the other volcanic islets of the South Atlantic it is needless to say that they are related to wrinkles in the trough of the ocean, and therefore have no immediate connection with the continental plateau.

Thus in the geographical development of the Atlantic coast-lines we may note the following stages:—*First*, during Palæozoic times a series of great mountain-uplifts, which were frequently accompanied by volcanic action. *Second*, a prolonged stage of comparative coastal tranquillity, during which the maritime ranges referred to were subject to such excessive erosion that they were planed down to low levels, and in certain areas even submerged. *Third*, renewed elevation (negative or positive) whereby considerable portions of the much denuded Archæan and Palæozoic rocks, now largely covered by younger deposits, were converted into high lands. During this stage not much rock-folding took place, nor were any true mountains of elevation formed parallel to the Atlantic margins. It was otherwise, however, in the Mediterranean and Caribbean depressions, where coastal movements resulted in the formation of enormous linear uplifts. Moreover, volcanic action is now and has for a long time been more characteristic of these depressions than of the Atlantic coast-lands.

I must now ask you to take a comprehensive glance at the coast-lines of the Pacific Ocean. In some important respects these offer a striking contrast to those we have been considering. Time will not allow me to enter into detailed description, and I must therefore confine attention to certain salient features. Examining first the shores of the Americas, we find that there are two well-marked regions of fiords and fringing islands—namely, the coasts of Alaska and British Columbia, and of South America from 40° S.L. to Cape Horn. Although these regions may be now extending seawards in places, it is obvious that they have recently been subject to submergence. When the fiords of Alaska and British Columbia existed as land valleys it is probable that a broad land connection obtained between North America and Asia. The whole Pacific coast is margined by mountain ranges, which in elevation and boldness far exceed those of the Atlantic sea-board. The rocks entering into their formation range in age from Archæan and Palæozoic, and they are almost everywhere highly disturbed and flexed. It is not necessary, even if it were possible, to consider the geological history of all those uplifted masses. It is enough for my purpose to note the fact that the coastal ranges of North America and the principal chain of the Andes were all elevated in Tertiary times. It may be remarked further, that from the Mesozoic period down to the present the Pacific borders of America have been the scene of volcanic activity far in excess of what has been experienced on the Atlantic sea-board.

Geographically the Asiatic coasts of the Pacific offer a strong contrast to those of the American borders. The latter, as we have seen, are for the most part not far removed from the edge of the continental plateau. The coasts of the mainland of Asia, on the other hand, retire to a great distance, the true margin of the plateau being marked out by that great chain of islands which extends from Kamchatka south to the Philippines and New Guinea. The seas lying between those islands and the mainland occupy depressions in the continental plateau. Were that plateau to be lifted up for 6,000 or 7,000 feet the seas referred to would be enclosed by continuous land, and all the principal islands of the Indian Archipelago—Sumatra, Java, Celebes, and New Guinea, would become united to themselves as well as to Australia and New Zealand. In short, it is the relatively depressed condition of the continental plateau along the western borders of the Pacific basin that caused the Asiatic coast-lines to differ so strikingly from those of America.

From a geological point of view the differences are less striking than the resemblances. It is true that we have as yet a very imperfect knowledge of the geological structure of Eastern Asia, but we know enough to justify the conclusion that in its main features that region does not differ essentially from Western North America. During Mesozoic and Cainozoic times the sea appears to have overflowed vast tracts of Manchooria and China, and even to have penetrated into what is now the great Desert of Gobi. Subsequent crustal movements revolutionised the geography of all those regions. Great ranges of linear uplifts came into existence, and in these the younger formations, together with the foundations on which they rested, were squeezed into folds and ridged up against the nuclei of Palæozoic and Archæan rocks which had hitherto formed the only dry land. The latest of these grand upheavals are of Tertiary age, and, like those of the Pacific slope of America, they were accompanied by excessive volcanic action. The long chains of islands that flank the shores of Asia we must look upon as a series of partially submerged or partially emerged mountain-ranges, analogous geographically to the coast ranges of North and Central America, and to the youngest Cordilleras of South America. The presence of numerous active and recently extinct volcanoes, taken in connection with the occurrence of many great depressions which furrow the floor of the sea in the East Indian Archipelago, and the profound depths attained by the Pacific trough along the borders of Japan and the Kurile and Aleutian Islands—all indicate conditions of very considerable instability of the lithosphere. We are not surprised, therefore, to meet with much apparently conflicting evidence of elevation and depression in the coast-lands of Eastern Asia, where in some places the sea would seem to be encroaching, while in other regions it is retreating. In all earthquake-ridden and volcanic areas such irregular coastal changes may be looked for. So extreme are the irregularities of the sea-floor in the area lying between Australia, the Solomon Islands, the New Hebrides, and New Zealand, and so great are the depths attained by many of the depressions, that the margins of the continental plateau are harder to trace here than anywhere else in the world. The bottom of the oceanic trough throughout a portion of the Southern and Western Pacific is, in fact, traversed by many great mountain rides, the summits of which approach the surface again and again to form the numerous islets of Polynesia. But notwithstanding the considerable depths that separate Australia and New Zealand there is geological evidence to show that a land connection formerly linked both to Asia. The continental plateau, therefore, must be held to include New Caledonia and New Zealand. Hence the volcanic islets of the Solomon and New Hebrides groups are related to Australia in the same way as the Riu-kiu, Japanese, and Kurile Islands are to Asia.

Having rapidly sketched the more prominent features of the Pacific coast-lines, we are in a position to realise the remarkable contrast they present to the coast-lines of the Atlantic. The highly folded strata of the Atlantic sea-board are the relics of great mountains of upheaval, the origin of which cannot be assigned to a more recent date than Palæozoic times. During subsequent crustal movements no mountains of corrugated strata were uplifted along the Atlantic margins, the Mesozoic and Cainozoic strata of the coastal regions showing little or no disturbance. It is quite in keeping with all this that volcanic action appears to have been most strongly manifested in Palæozoic times. So many long ages have passed since the upheaval of the Archæan and Palæozoic mountains of the Atlantic sea-board that these heights have everywhere lost the character of true mountains of elevation. Planed down to low levels, partially submerged and covered to some extent by newer formations, they have in many places been again converted into dry lands, forming plateaus—now sorely denuded and cut up into mountains and valleys of erosion. Why the later movements along the borders of the Atlantic basin should not have resulted in the wholesale plication of the younger sedimentary rocks is a question for geologists. It would seem as if the Atlantic margins had reached a stage of comparative stability long before the grand Tertiary uplifts of the Pacific borders had taken place; for, as we have seen, the Mesozoic and Cainozoic strata of the Atlantic coast-lands show little or no trace of having been subjected to tangential thrusting and crushing. Hence one cannot help suspecting that the retreat of the sea during Mesozoic and Cainozoic ages may have been due rather to subsidence of the oceanic trough and to sedimentation within the continental area than to positive elevation of the land.

Over the Pacific trough, likewise, depression has probably been in progress more or less continuously since Palæozoic times, and this movement alone must have tended to withdraw the sea from the surface of the continental plateau in Asia and America. But by far the most important coastal changes in those regions have been brought about by the crumpling up of the plateau, and the formation of gigantic mountains of upheaval along its margins. From remotest geological periods down almost to the present the land area has been increased from time to time by the doubling-up and consequent elevation of coastal accumulations and by the eruption of vast masses of volcanic materials. It is this long-continued activity of the plutonic forces within the Pacific area which has caused the coast-lands of that basin to contrast so strongly with those of the Atlantic. The latter are incomparably older than the former—the heights of the Atlantic borders being mountains of denudation of vast geological antiquity, while the coastal ranges of the Pacific slope are creations but of yesterday as it were. It may well be that those Cordilleras and mountain-chains reach a greater height than was ever attained by any Palæozoic uplifts of the Atlantic borders. But the marked disparity in elevation between the coast-lands of the Pacific and the Atlantic is due chiefly to a profound difference in age. Had the Pacific coast-lands existed for as long a period and suffered as much erosion as the ancient rocks of the Atlantic sea-board, they would now have little elevation to boast of.

The coast-lines of the Indian Ocean are not, upon the whole, far removed from the margin of the continental plateau. The elevation of East Africa for 6000 feet would add only a very narrow belt to the land. This would still leave Madagascar an island, but there are geological reasons for concluding that this island was at a far distant period united to Africa, and it must therefore be considered as forming a portion of the continental plateau. The great depths which now separate it from the mainland are probably due to local subsidence, connected with volcanic action in Madagascar itself and in the Comoro Islands. The southern coasts of Asia, like those of East Africa, approach the edge of the continental plateau, so that an elevation of 6000 feet would make little addition to the land area. With the same amount of upheaval, however, the Malay Peninsula, Sumatra, Java, and West Australia, would become united, but without extending much further seawards. Land connection, as we know, existed in Mesozoic times between Asia, Australia, and New Zealand, but the coast-lines of that distant period must have differed considerably from those that would appear were the regions in question to experience now a general elevation. The Archæan and Palæozoic rocks of the Malay Peninsula and Sumatra are flanked on the side of the Indian Ocean by great volcanic ridges, and by uplifts of Tertiary strata, which continue along the line of the Nicobar and Andaman Islands into Burma. Thus the coast-lines of that section of the Indian Ocean exhibit a geographical development similar to that of the Pacific seaboard. Elsewhere, as in Hindustan, Arabia, and East Africa, the coast-lines appear to have been determined chiefly by regional elevations of the land or subsidence of the oceanic trough in Mesozoic and Cainozoic times, accompanied by the outwelling of enormous floods of lava. Seeing, then, that the Pacific and Indian Oceans are pre-eminently regions which, down to a recent date, have been subject to great crustal movements and to excessive volcanic action, we may infer that in the development of their coast-lines the sea has played a very subordinate part. The shores, indeed, are largely protected from marine erosion by partially emerged volcanic ridges and by coral islands and reefs, and to a considerable extent also by the sediment which in tropical regions especially is swept down to the coast in great abundance by rains and rivers. Moreover, as the geological structure of these regions assures us, the land would appear seldom to have remained sufficiently long at one level to permit of much destruction by waves and tidal currents.

In fine, then, we arrive at the general conclusion that the coast-lines of the globe are of very unequal age. Those of the Atlantic were determined as far back as Palæozoic times by great mountain uplifts along the margin of the continental plateau. Since the close of that period many crustal oscillations have taken place, but no grand mountain ranges have again been ridged up on the Atlantic sea-board. Meanwhile the Palæozoic mountain-chains, as we have seen, have suffered extensive denudation, have been planed down to the sea-level, and even submerged. Subsequently converted into land, wholly or partially as the case may have been, they now present the appearance of plains and plateaus of erosion, often deeply indented by the sea. No true mountains of elevation are met with anywhere in the coast-lands of the Atlantic, while volcanic action has well-nigh ceased. In short, the Atlantic margins have reached a stage of comparative stability. The trough itself, however, is traversed by at least two well-marked banks of upheaval—the great meridional Dolphin Ridge, and the approximately transmeridional Færöe-Icelandic belt—both of them bearing volcanic islands.

But while the coast-lands of the Atlantic proper attained relative stability at an early period, those of the Mediterranean and Caribbean depressions have up to recent times been the scenes of great crustal disturbance. Gigantic mountain-chains were uplifted along their margins at so late a period as the Tertiary, and their shores still witness volcanic activity.

It is upon the margins and within the troughs of the Pacific Ocean, however, that subterranean action is now most remarkably developed. The coast-lines of that great basin are everywhere formed of grand uplifts and volcanic ranges, which, broadly speaking, are comparable in age to those of the Mediterranean and Caribbean depressions. Along the north-east margin of the Indian Ocean the coast-lines resemble those of the Pacific, being of like recent age, and similarly marked by the presence of numerous volcanoes. The northern and western shores, however (as in Hindustan, Arabia, and East Africa), have been determined rather by regional elevation or by subsidence of the ocean-floor than by axial uplifts—the chief crustal disturbances dating back to an earlier period than those of the East Indian Archipelago. It is in keeping with this greater age of the western and northern coast-lands of the Indian Ocean that volcanic action is now less strongly manifested in their vicinity.

I have spoken of the comparative stability of the earth's crust within the Atlantic area as being evidenced by the greater age of its coastal ranges and the declining importance of its volcanic phenomena. This relative stability is further shown by the fact that the Atlantic sea-board is not much disturbed by earthquakes. This, of course, is what might have been expected, for earthquakes are most characteristic of volcanic regions and of those areas in which mountain-uplifts of recent geological age occur. Hence the coast-lands of the Pacific and the East Indies, the borders of the Caribbean Sea, the volcanic ridges of the Atlantic basin, the lands of the Mediterranean, the Black Sea, and the Aralo-Caspian depressions, the shores of the Red Sea, and vast tracts of Southern Asia, are the chief earthquake regions of the globe. It may be noted, further, that shocks are not only most frequent but most intense in the neighbourhood of the sea. They appear to originate sometimes in the volcanic ridges and coastal ranges, sometimes under the floor of the sea itself. Now earthquakes, volcanoes, and uplifts are all expressions of the one great fundamental fact that the earth is a cooling and contracting body, and they indicate the lines of weakness along which the enormous pressures and strains induced by the subsidence of the crust upon its nucleus find relief. We cannot tell why the coast-lands of the Atlantic should have attained at so early a period a stage of relative stability—why no axial uplifts should have been developed along their margins since Palæozoic times. It may be that relief has been found in the wrinkling-up of the floor of the oceanic trough, and consequent formation of the Dolphin Ridge and other great submarine foldings of the crust. And it is possible that the growth of similar great ridges and wrinkles upon the bed of the Pacific may in like manner relieve the coast-lands of that vast ocean, and prevent the formation of younger uplifts along their borders.

I have already remarked that two kinds of elevatory movements of the crust are recognized by geologists—namely, axial and regional uplifts. Some, however, are beginning to doubt, with Professor Suess, whether any vast regional uplifts are possible. Yet the view that would attribute all such apparent elevations of the land to subsidence of the crust under the great oceanic troughs is not without its difficulties. Former sea-margins of very recent geological age occur in all latitudes, and if we are to explain these by sub-oceanic depression, this will compel us to admit, as Suess has remarked, a general lowering of the sea-level of upwards of 1,000 feet. But it is difficult to believe that the sea-floor could have subsided to such an extent in recent times. Suess thinks it is much more probable that the high-level beaches of tropical regions are not contemporaneous with those of higher latitudes, and that the phenomena are best explained by his hypothesis of a secular movement of the ocean —the water being, as he contends, alternately heaped up at the equator and the poles. The strand-lines in high latitudes, however, are certainly connected with glaciation in some way not yet understood. And if it cannot be confidently affirmed that they indicate regional movements of the land, the evidence, nevertheless, seems to point in that direction.

In concluding this imperfect outline-sketch of a large subject, I ought perhaps to apologize for having trespassed so much upon the domains of geology. But in doing so I have only followed the example of geologists themselves, whose divagations in territories adjoining their own are naturally not infrequent. From much that I have said, it will be gathered that with regard to the causes of many coastal changes we are still groping in the dark. It seems not unlikely, however, that as light increases we may be compelled to modify the view that all oscillations of the sea-level are due to movements of the lithosphere alone. That is a very heretical suggestion; but that a great deal can be said for it anyone will admit after a candid perusal of Suess's monumental work, "Das Antlitz der Erde."

SECTION G.

MECHANICAL SCIENCE.

OPENING ADDRESS BY W. CAWTHORNE UNWIN, F.R.S., M.INST.C.E., PRESIDENT OF THE SECTION.

BY what process selection is made of a Sectional President of the British Association is to me unknown. I may confess that it was pleasant to receive the request of the Council to preside at the meetings of Section G, even though much of the pleasure was due to its unexpectedness. I ventured to believe I might accept the honour gratefully, trusting to your kindness to assist me in fulfilling its obligations. Amongst engineers there are many with greater claims than I have to such a position, and who could speak to you from a wider practical experience. Here in Section G, I think it may be claimed that the profession of engineering owes much to some who from circumstances or natural bias have concerned themselves more with those scientific studies and experimental researches which are useful to the engineer, than with the actual carrying on of engineering operations. Here, at so short a distance from the University where Rankine and James Thomson laboured, I may venture to feel proud of being amongst those whose business it has been rather to investigate problems than to execute works.

The year just passed is not one unmemorable in the annals of engineering. By an effort remarkable for its rapidity, and as an example of organization of labour, the broad gauge system has been extinguished. It has disappeared like some prehistoric mammoth, a large-limbed organism, perfect for its purpose and created in a generous mood, but conquered in the struggle for existence by smaller but more active rivals. If we recognize that the great controversy of fifty years ago has at last been decided against Brunel, at least we ought to remember that the broad gauge system was one only of many original experiments due to his genius and courage, experiments in every field of engineering, in bridge building, in locomotive design, in ship construction, the successes and failures of which have alike enlarged the knowledge of engineers and helped the progress of engineering.

The past year has seen the completion of the magnificent scheme of water supply for Liverpool, from the Vyrnwy, carried out from 1879 to 1885 by Mr. Hawksley and Mr. Deacon, and since then completed under the direction of the latter engineer. This is one of the largest and most striking of those works of municipal engineering rendered necessary by the growth of great city communities and made possible by their wealth and public spirit. For the supply of water to Liverpool, the largest artificial lake in Europe has been created in mid-Wales, by the contruction across a mountain valley of a dam of cyclopean masonry, itself one of the most remarkable masonry works in the world. The lake contains an available supply of over 12,000 million gallons, its size having been determined not only to supply forty million gallons daily for the increasing demand of Liverpool, but also to meet the necessity imposed by Parliament that an unprecedentedly large compensation, amounting to ten million gallons daily and fifty million gallons additional on thirty-two days yearly, should be afforded to the Severn. The masonry dam, though a little less in height than some of the French dams, is of greater length. It is nearly double the length of the great dam at Verviers.[1] Athough masonry dams were an old expedient of engineers, it is in quite recent times, and chiefly in consequence of the scientific investigations of French engineers, that they have been revived in engineering practice. Since the completion of the Vyrnwy dam, another very large dam, the Tansa dam, has been completed in Bombay. This dam has a length of two miles and a height of 118 feet, and it is 100 feet thick at the base. The reservoir will supply 100 million gallons per day. In the United States a still greater work of the same kind has been commenced on the Croton river, in connection with the water supply of New York. This dam will have a length of 2000 feet, and a height of 285 feet. Its greatest thickness will be 215 feet. It will be very much the boldest work of its kind.

Returning to the Liverpool supply, the water taken from the lake at the most suitable level into a straining tower provided with very complete hydraulic machinery, passes through the Hirnant tunnel, and thence by an aqueduct, partly consisting of rock tunnels, partly of pipes 39in. to 42in. in diameter, sixty-eight miles in length, being the longest aqueduct yet constructed. The crossing of the Mersey by an aqueduct tunnel has proved the greatest engineering difficulty to be surmounted. The tunnel has been carried through layers of running sand, gravel, and silt. At first slow progress was made, but later, by the adoption of the Greathead system of shield, with air locks and air-compressing machinery, as much as fifty-seven feet of tunnel were driven and lined in one week. The whole work is now complete, and Liverpool has available an extra supply of very pure water, amounting to forty million gallons daily.

A scheme of water supply for Manchester from Lake Thirlemere in Westmoreland, on an equally large scheme, is approaching completion. Birmingham is likely to carry out another work of the same kind. And London, at a greater distance from pure water sources and under greater difficulties from the complexity of existing interests, has come to realize that, within fifty years, a population of 12½ millions will probably have to be provided for. To supply such a population, a volume of water is required ten times as great as the whole available supply from Lake Vyrnwy.

Here in Edinburgh one remembers that the birth-place of the steam-engine is near at hand. A century and a quarter ago James Watt made an invention which has profoundly influenced all the conditions of social, national, commercial, and industrial life. It is due to the steam-engine more than to any other single cause that the population in this country has tripled since the beginning of the century, and that we have become dependent on steam-power for fuel, for transport, for manufactures, in many cases for water supply, for sanitation, and for artificial light. From some German statistics it appears that there are probably now in the world, employed in industry, steam-engines exerting 49 million horse-power, besides locomotives exerting six million horse-power. Engines in steam-ships are not included. The steam-engine has become a potent factor in civilization, because it places at our disposal mechanical energy at a sufficiently low cost, and the efforts of engineers have been steadily directed to diminishing the cost at which steam-power is produced. Members of one great branch of our profession are much concerned in the production of mechanical energy at a sufficiently cheap rate. They require it in very large quantity for transformation into light and for re-transformation into mechanical energy under conditions more convenient than the direct use of steam-power. Perhaps it will not be inappropriate if in Section G I first discuss briefly some of the causes which have made the steam-engine inefficient and the extent to which we are getting to a scientific knowledge of the methods of evading them. I propose then to consider some of the methods of economizing the cost and increasing the convenience of mechanical power by generating it at central stations and distributing it, and lastly, how far means of transporting energy are likely to make available cheaper sources of energy than steam-power.

Let us go back for a moment to James Watt. The most distinct feature about the invention of the steam-engine is that it arose out of studies of such questions as the relation of pressure and temperature of steam, the heat absorbed in producing it, and its volume at different pressures.

Armed with this knowledge, Watt was able to determine that the quantity of steam used in a model atmospheric engine was enormously greater than that due to the volume described by the piston. There was waste or loss. To discover the loss was to get on the path of finding a remedy. The separate condenser, by diminishing cylinder condensation, annulled a great part of the loss. So great was Watt's insight into the action of the engine that he was able to leave it so perfect that, except in one respect, little remained for succeeding engine builders, except to perfect the machines for its manufacture, to improve its details, and to adapt it to new purposes. Now it very early became clear that there were two directions of advance which ought to secure greater economy. Simple mechanical indications showed that increased expansion ought to ensure increased economy. Thermodynamic considerations indicated that higher pressures, involving a greater temperature range of working, ought to secure greater economy. But in attempting to advance in either of these directions, engineers were more or less disappointed. Some of Watt's engines worked with 5 lbs. of coal per indicated horse-power per hour. Many engines with greater pressures and longer expansions have done but little better. The history of steam-engine improvement for a quarter of a century has been an attempt to secure the advantages of high pressures and high ratios of expansion. The difficulty to be overcome has proved to be due to the same cause as the inefficiency of Watt's model engine. The separate condenser diminished, but it did not annul, the action of the cylinder wall. The first experiments which really startled thoughtful steam engineers were those made by Mr. Isherwood, between 1860 and 1865. Mr. Isherwood showed that in engines such as those then in use in the United States Navy, with the large cylinders and low speeds then prevalent, any expansion of the steam beyond three times led, not to an increased economy, but to an increased consumption of steam. Very little later than this M. Hirn undertook, in 1871–5, his classical researches on the action of the steam in an engine of about 150 indicated horse-power. Experiments of greater accuracy or completeness, or of greater insight into the conditions which were important, have never since been made, and Hirn with his assistants, MM. Hallaner and Dwelshauvers Dery, has determined, once for all, the whole method of a perfect steam-engine trial. M. Hirn was the first to clearly realize that the indicator gives the means of determining the steam present in the cylinder during every period of the cycle of the engine. Consequently, superheating in ordinary cases being out of the question, we have the means of determining the heat present and the heat already converted into work. The heat delivered into the engine is known from boiler measurements, combined with calorimetric tests of the quality of the steam, tests which Hirn was the first to undertake. The balance or heat unaccounted for is, then, a waste or loss due to causes which have to be investigated. Hirn originated a complete method of analysis of an engine test, showing at every stage of the operation the heat accounted for and a balance of heat unaccounted for; and the latter proved to be a very considerable quantity.

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[1] The length of the dam from rock to rock is 1172 feet. Height from lowest part of foundation to parapet of carriage way, 161 feet. Height from bed of river to overflow sill, 84 feet. Thickness of masonry at base, 120 feet.

Meanwhile theoretical writers, especially Rankine and Clausius, had been perfecting a thermodynamic theory of the steam-engine, based primarily on the remarkable and irrefragable principle of Carnot. The result of Hirn's analysis was to show that these theories, applied to the actual steam-engine, were liable to lead to errors of 50 or 60 per cent., the single false assumption made being that the interaction between the walls of the cylinder and the steam was an action small enough to be negligeable.

In this country Mr. Mair Rumley, following Hirn's method, made a series of experiments on actual engines with great care and accuracy and completeness. All these experiments demonstrated the fact of a large initial condensation of steam on the walls of the cylinder, alike in jacketed and unjacketed engines. This condensed steam is re-evaporated partially during expansion, but mainly during exhaust, and serves as a mere carrier of heat from boiler to condenser, in conditions not permitting its utilization in producing work.

It became clear from Hirn's experiments, if not from the earlier experiments of Isherwood, that for each engine there is a particular ratio of expansion for which the steam expenditure per horse-power is least. Professor Dery has since deduced from them that the practical condition of securing the greatest efficiency is that the steam at release should be nearly dry. In producing that dryness the jacket has an important influence. In spite of much controversy amongst practical engineers about the use of the jacket, it does not appear that any trustworthy experiment has yet been adduced in which there was an actual loss of efficiency due to the jacket. In the older type of comparatively slow engines it is a rule that the greater the jacket condensation the greater the economy of steam, even when the jacket condensation approaches 20 per cent. of all the steam used. It appears, however, that as the speed of the engine increases, the influence of the jacket diminishes, so that for any engine there is a limit of speed at which the value of the jacket becomes insignificant.

Among steam-engine experiments directed specially to determine the action of the cylinder walls, those of the late Mr. Willans should be specially mentioned. Mr. Willans' death is to be deplored as a serious loss to the engineering profession. His steam-engine experiments, some of them not yet published, are models of what careful experiments should be. They are graduated experiments designed to indicate the effect of changes in each of the practically variable conditions of working. They showed a much greater variation of steam consumption (from 46 to 18 lbs. per indicated horse-power hour) in different conditions of working than, I think, most practical engineers suspected, and this has been made more significant in later experiments, on engines working with less than full load. The first series showed that in full load trials the compound was superior to the simple engine in practically all the conditions tried, but that the triple was superior to the compound only when certain limits of pressure and speed were passed.

As early as 1878 Prof. Cotterill had shown that the action of a cylinder wall was essentially equivalent to that of a very thin metallic plate, following the temperature of the steam. The exceedingly rapid dissipation of heat from the surface during exhaust especially being due to the evaporation of a film of water initially condensed on its surface. In permanent *régime* the heat received in admission must be equal to that lost after cut off. In certain conditions it appeared that a tendency would arise to accumulate water on the cylinder surfaces, with the effect of increasing in certain cases the energy of heat dissipation. Recently Prof. Cotterill has been able to carry much further the analysis of the complex action of condensation and re-evaporation in the cylinder, and to discriminate in some degree between the action of the metal and the more ambiguous action of the water film. By discarding the less important actions, Prof. Cotterill has found it possible to state a semi-empirical formula for cylinder condensation in certain restricted cases which very closely agrees with experiments on a wide variety of engines. It is to be hoped that, with the data now accumulating, a considerable practical advance may be made in the clearing up of this complex subject. There are, no doubt, some people who are in the habit of depreciating quantitative investigations of this kind. They are as wise as if they recommended a manufacturer to carry on his business without attending to his account books. Further, the attempt to obtain any clear guidance from experiments on steam-engines has proved a hopeless failure without help from the most careful scientific analysis. There is not a fundamental practical question about the thermal action of the steam-engine, neither the action of jackets or of expansion or of multiple cylinders, as to which contradictory results have not been arrived at, by persons attempting to deduce results from the mass of engine tests without any clear scientific knowledge of the conditions which have affected particular results. In complex questions fundamental principles are essential in disentangling the results. Interpreted by what is already known of thermodynamic actions, there are very few trustworthy engine tests which do not fall into a perfectly intelligible order. There is only one known method, not now much used, by which the cylinder condensation can be directly combated. Thirty years ago superheating the steam was adopted with very considerable increase of economy. It is likely that it was thought by the inventor of superheating that an advantage would be gained by increasing the temperature range. If so, his theory was probably a mistaken one. For the cooling action of the cylinder is so great that the steam is reduced to saturation temperature before it has time to do work; but the economy due to superheating was unquestionable, and was very remarkable considering how small a quantity of heat is involved in superheating. The heat appears to diminish the cylinder wall action so much as almost to render a jacket unnecessary. The plan of superheating was abandoned from purely practical objections, the superheaters then constructed being dangerous. Recently superheating has been tried again at Mulhouse by M. Meunier, and his experiments are interesting because they are at higher pressures than in the older trials and with a compound engine. It appears that even when the superheater was heated by a separate fire there was an economy of steam of 25 to 30 per cent. and an economy of fuel of 20 to 25 per cent., and four boilers with superheating were as efficient as five without it.

It may be pointed out as a point of some practical importance that if a trustworthy method of superheating could be found, the advantage of the triple over the compound engine would be much diminished. For marine purposes the triple engine is perfectly adapted. But for other purposes it is more costly than the compound engine, and it is less easily arranged to work efficiently with a varying load.

There does not seem much prospect of exceeding the efficiency attained already in the best engines, though but few engines are really as efficient as they might be, and there are still plenty of engines so designed that they are exceedingly uneconomical. The very best engines use only from 12 to 13 lbs. of steam per indicated horse-power hour, having an absolute efficiency reckoned on the indicated power of 16 per cent., or reckoned on the effective power, 13 per cent. The efficiency, including the loss in the boiler, is only about 9 per cent. But there are internal furnace engines of the gas-engine or oil-engine type in which the thermal efficiency is double this.

In his interesting address to this Section in 1878, Mr. Easton expressed the opinion that the question of water-power was one deserving more consideration than it had lately received, and he pointed to the variation of volume of flow of streams as the principal objection to their larger utilization. Since that time the progress made in systems of transporting and distributing power has given quite a new importance to the question of the utilization of water-power. There seems to be a probability that in many localities water-power will, before long, be used on a quite unprecedented scale, and under conditions involving so great convenience and economy that it may involve a quite sensible movement of manufacturers towards districts where water-power is available.

If we go back to a period not very distant in the history of the world, to the middle of the last century, we reach the time when textile manufactures began to pass from the condition of purely domestic industries to that of a factory system. The fly-shuttle was introduced in 1750, the spinning-jenny was invented in 1767, and Crompton's machine only began to be generally used in 1787. It was soon found that the new machines were most suitably driven by a rotary motion, and after some attempts to drive them by horses, water-power was generally resorted to. In an interesting pamphlet on the Rise of the Cotton Trade, by John Kennedy, of Ardwick Hall, written in 1815, it is pointed out that the necessity of locating the mills where water-power was available, had the disadvantages of taking them away from the places where skilled workmen were found, and from the markets for the manufactured goods. Nevertheless, Mr. Kennedy states that for some time after Arkwright's first mill was built at Cromford, all the principal mills were erected near river falls, no other power than water-power having been found practically useful. "About 1790," says Mr. Kennedy, "Mr. Watt's steam-engine began to be understood, and waterfalls became of less value. Instead of carrying the workpeople to the power, it was found preferable to place the power amongst the people."

The whole tendency of the conditions created by the use of steam-power has been to concentrate the industrial population in large communities, and to restrict manufacturing operations to large factories. Economy in the production of power, economy in superintendence, the convenience of the subdivision of labour, and the costliness of the machines employed, all favoured the growth of large factories. The whole social conditions of manufacturing centres have been profoundly influenced by these two conditions—that coal for raising steam can be easily brought to any place where it is wanted, and that steam-power is more cheaply produced on a large scale than on a small scale. It looks rather, just now, as if facilities for distributing power will to some extent reverse this tendency.

Let me first point out that water-power, where it is available, is so much cheaper and more convenient than steam-power that it has never been quite vanquished by steam-power.

I find, from a report by Mr. Weissenbach, that in 1876 70,000 horse-power derived from waterfalls were used in manufacturing in Switzerland. According to a census in 1880, it appears that the total steam and water-power employed in manufacturing operations in the United States was 3,400,000 horse-power. Of this, 2,185,000 horse-power, or 64 per cent., was derived from steam, and 1,225,000 horse-power, or 36 per cent., from water. In the manufacture of cotton and woollen goods, of paper and of flour, 760,000 horse-power were obtained from water, and 515,000 horse-power from steam. If statistics could be obtained from other countries, I believe it would be found that a very large amount of water-power is actually made available. The firm of Escher Wyss and Company, of Zurich, have constructed more than 1800 turbines of an aggregate power of 111,460 horse-power.

With a very limited exception all the water-power at present used is employed in the neighbourhood of the fall where it is generated. If means were available for transporting the power from the site of the fall to localities more convenient for manufactures, there can be no doubt that a much larger amount of water-power would be used, and the relative importance of water and steam power in some countries would probably be reversed. It is because recent developments seem to make such a transport of power possible without excessive cost and without excessive loss, that a most remarkable interest has been excited in the question of the utilization of water-power. Take the case of Switzerland for instance. At the present time Switzerland is said to pay to other countries £800,000 annually for coal. But the total available water-power of Switzerland is estimated at no less than 582,000 horse-power, of which probably only 80,000 are at present utilized. I found a year ago that nearly every large industrial concern in Switzerland was preparing to make use of water-power, transported a greater or less distance. Besides the great schemes actually carried out at Schaffhausen, Bellegarde, Geneva, and Zurich, where water-power is already utilized on a very large scale, there is a project to develop 10,000 horse-power on the Dranse near Martigny.

Hence it is easy to see that problems of distribution of power—that is, the transformation of energy into forms easily transportable and easily utilizable—have now a great interest for engineers.

Besides the power required for manufacturing operations, there is a steadily increasing demand for easily available mechanical energy in large towns. For tramways, for lifts, for handling goods, for small industries, for electric lighting, and sometimes for sanitation, power is required. Hitherto steam-engines, or more lately gas-engines, have been used, placed near the work to be done. But this sporadic generation of power is uneconomical and costly, especially when the work is intermittent; the cost of superintendence is large, and the risk of accident considerable. Hence attention is being directed to systems in which the mechanical energy of fuel or falling water is first generated in large central stations, transformed into some form in which it is conveniently transportable and capable of being rendered available by simpler motors than steam-engines.

Just as in great towns it has become necessary to supersede private means of water supply by a municipal supply; just as it has proved convenient to distribute coal-gas for lighting and heating, and to provide a common system of sewerage, so it will probably be found convenient to have in all large towns some means of obtaining mechanical power in any desired quantity at a price proportionate to the quantity used, and in a form in which it can be rendered available, either directly or by simple motors requiring but little skilled superintendence.

Telodynamic Transmission.—First, then, let me say a few words as to the modes of distributing power which it is possible to adopt. In 1850, at Logelbach in Alsace, M. Ferdinand Hirn used a flat steel belt to transmit power directly a distance of eighty metres. Subsequently a wire rope was used on grooved pulleys. This worked so well that a second transmission to a distance of 240 metres was erected. The details of the system were worked out with great care with a view to securing the least cost of construction, the least waste of energy, and the greatest durability of the ropes. So successful did this system of telodynamic transmission prove that within ten years M. Martin Stein, of Mulhouse, had erected 400 transmissions, conveying 4200 horse-power, and covering a distance of 72,000 metres.

Just at this time a very able and far-seeing manufacturer at Schaffhausen, Herr Moser, had formed a project for reviving the failing industries of the town by utilizing part of the water-power of the Rhine: Hirn's system of wire-rope transmission rendered this project practicable. The works were commenced in 1863. Three turbines of 750 horse-power were erected on a fall which varies from 12 to 16 feet, created by a weir across the river. From the turbines the power is transmitted by two cables, in one span of 392 feet, across the river. Similar cables distribute the power to factories along the river bank. In 1870 the transmission extended to a distance of 3400 feet. Power is sold at rates varying from £5 to £6 per horse-power per annum. In 1887 there were twenty-three consumers of power paying a rental of £3500 per annum for power. The project has been financially successful, and is still working. At Zurich, Freiberg, and Bellegarde there are similar installations, and a large scheme of the same kind has recently been carried out at Gokak in India. Wire-rope transmissions are of great mechanical simplicity, and the loss of power in transmission is exceedingly small. They are extremely suitable for certain cases where a moderate amount of power has to be transmitted a moderate distance, to one or to a few factories. On the other hand, they become cumbrous if the amount of power transmitted exceeds 600 or 1000 horse-power. The wear of the ropes, which only last a year, has proved greater than was expected, and is a source of considerable expense.

The practical introduction of a system of distributing power by *pressure water* is due to Lord Armstrong. Such a system involves a central pumping station, a series of distributing mains, and suitable working motors. From its first introduction the peculiar advantages of this system for driving intermittently working machines, such as lifts, dock machinery, railway cranes, and hauling gear, became obvious. But, with intermittent working machines, there rose the need of an appliance for storing energy during periods of minimum demand and restoring it in periods of maximum demand. The invention of the accumulator by Lord Armstrong made the system of hydraulic transmission a success, and at the same time fixed its character as a system specially adapted for those cases where intermittent work is required to be done. Lord Armstrong's system of hydraulic distribution by water at a pressure of 700 or 800 lbs. per square inch, with the use of accumulators for equalizing the variations of supply and demand, has now been widely adopted. The most extensive scheme of that kind hitherto executed is the important scheme carried out by the Hydraulic Power Company. Over fifty miles of pressure mains have now been laid in the streets of London. The Falcon Wharf pumping station contains four sets of compound pumping engines, each of 200 horse-power. Two additional pumping stations have now been erected, and 1500 lifts are worked from the pressure mains. The minimum charge for water is 2*s.* per 1000 gallons. This rate of charge is economical for such machines as lifts, but it would be extravagant for machines working continuously. It would be equivalent to a charge of nearly £50 per horse-power per year of 3000 working hours, apart from interest and maintenance of machines.

I shall indicate later on that in some cases where local conditions are favourable, where there is cheap water-power, and the possibility of constructing high-level storage reservoirs, then hydraulic transmission can be adopted with success for distributing power for ordinary manufacturing purposes. But neither telodynamic transmission nor hydraulic transmission have proved suitable as methods for the general distribution of motive power from central stations. Distribution by steam and distribution by heated water have both been tried in the United States, but not with very remarkable success. Only two other methods are available—distribution by compressed air and distribution by electricity.

For many years *compressed air* has been used to distribute power in tunnelling and mining operations to considerable distances. It is only recently that it has been used as a general method of distributing power to many consumers. In many installations the machinery has been rough and unscientific, and the waste of energy very considerable. It is through experience gained and improvements carried out in the remarkable system now at work in Paris, and known as the Popp system, that the great advantages of compressed air distribution have been proved. The Paris system has very gradually developed. About 1870 a small compressing station was erected to actuate public and private clocks by intermittent pulses of air conveyed along pipes chiefly laid in the sewers. In 1889 about 8000 clocks were thus driven. Meanwhile the compressed air had also been applied to drive motors for small industries. The demand for power thus supplied grew so rapidly that a second compressing station was built in the Rue de Saint Fargeau. In 1889 steam air compressors of 2000 horse-power were at work, and additional compressors were under construction. The pressure at that time was five atmospheres, and the largest air mains were 12 inches in diameter. Ingenious and simple rotary machines were used as air motors for small powers, and for larger powers any ordinary steam-engine was converted into an air motor. Prof. Kennedy made tests in 1889, which were communicated to this Association. He found that a motor four miles from the compressing station indicated 10 horse-power for 20 indicated horse power expended at the compressing station, an efficiency of 50 per cent. only. There were then 225 motors worked from the air mains.

Since 1889 more extended investigations have been made by Professor Riedler, of Berlin, and the chief part of the waste of work has been traced to inefficiency of the air compressors. Compound air compressors of much higher efficiency have now been constructed. The plant at the Saint Fargeau station has been increased to 4000 horse-power. A new station has been erected on the Quai de la Gare, intended ultimately to contain compressors of 24,000 horse-power. Compressors of 10,000 horse-power are already under construction.

Compressed air transmission, whether or not it is the most economical system, is undoubtedly applicable for the distribution of power on a very large scale and to very considerable distances. There is nothing in any of the appliances which is novel or imperfectly understood. The air is used in the consumer's premises in machinery of well-understood types, and old steam engines can be converted into air motors without difficulty and without alteration of existing transmissive machinery in the factories. Not least important, the air can be measured with accuracy enough for practical purposes by simple meters, and charged for in proportion to the power consumed. Air compressors and air motors are not as efficient as dynamos and electric motors, but in one respect distribution by air and electricity are similar. For distances which are not more than a few miles the loss of energy in transmission is small enough to be insignificant.

There is yet one other mode of power distribution which promises to become the most important of all, and which, in the case of transmission to very great distances, if such transmission becomes necessary, has undoubtedly great advantages over every other method.

About *electrical distribution* of power I shall not venture to say much, partly because I am not an electrical expert, partly because it has been lately pretty fully discussed. In the United States there has been an enormous development of electric tramways, which are essentially cases of electric power distribution. In this country we have the South London and some other railways worked electrically. There are others also on the Continent. But electrical power distribution to private consumers for industrial purposes has not yet made as much progress as might have been expected. Perhaps electrical engineers have been so busy with problems of electric lighting that they have had no time to settle the corresponding problems of power distribution.

No doubt continuous current distribution presents at the moment the fewest difficulties, or, at any rate, involves the fewest comparatively untried expedients. Several continuous-current plants for distributing power are in operation, of which perhaps the most interesting is that at Oyonaz, which was described in Section G last year by Prof. G. Forbes. There 300 horse-power obtained by turbines is transmitted 8 kilometres at 1800 volts. It is then let down by motor transformers to a voltage suitable for lighting and driving motors. A number of small workshops are driven, the power being supplied at a fixed rent.

At the Calumet and Hecla mines on Lake Superior, at the Dalmatia mines in California, and some other places, energy derived from turbines is transmitted distances of a mile or two by continuous electric currents and used in driving mining machinery, and some cases of the use of electrical distribution in mines in this country were mentioned by my predecessor in his address last year.

At Bradford a few electric motors are being worked from the electric lighting mains. The largest of these is of twenty horse-power. The price at which the electricity is supplied is not given, but I believe the cost is high when reckoned for continuous working. It would seem that it must be so when the electric current is generated by steam power.

At Schaffhausen an electric transmission has now been constructed alongside of the wire-rope transmission. The power is derived from two turbines, and is transmitted across the Rhine, a distance of 750 yards, at 624 volts. The current drives a spinning-mill, in which the largest motor is 380 horse-power. The power is sold, I believe, at £3 per horse-power of the motors per annum.

Many engineers have now apparently come to the conclusion that alternating currents will be better for power transmission to considerable distances than continuous currents. One interesting alternate current transmission, partly for power, partly for lighting purposes, has been for some time in operation at Genoa.

On the line of the aqueduct bringing water from the Gorzente rivulet three electric stations are being established. The reservoirs are 2050 feet above Genoa, and as this is a much greater fall than is required for water-supply purposes, part can be used to generate about 1600 horse-power.

In the first of the power stations erected there are turbines of 450 horse-power driving two dynamos. A second larger station was completed in November. In this there are eight alternate-current dynamos of 70 horse-power each. Six alternators are worked in series, transmitting a current of 6000 volts. The current is transmitted sixteen miles by bare copper wires, 8·5 mm. diameter, placed overhead. The current is used both for lighting and power purposes.

Another method of using alternating currents was adopted in the remarkable experiment at Frankfort last year. In that case energy obtained by turbines at Lauffen was transmitted to

Frankfort, a distance of 108 miles, and used for lighting and driving a motor. The current was obtained at low tension, transformed up to a tension of 18,000 to 27,000 volts for transmission, and then transformed down again for distribution. The loss in the conducting wires ranged from 5 horse-power when the turbines worked at 100 horse-power, to 25 horse-power when the turbines worked at 200 horse-power. The efficiency of dynamo, two transformers, and line ranged from 68 to 75 per cent., a remarkably satisfactory result.

There can be little doubt that if efficient and durable transformers can be constructed, they do give a considerable advantage to an alternate-current system. To an ordinary engineer it appears also that the system of producing current at a low tension in the dynamo, and using it at low tension in the motors, permits the construction of dynamos and motors more mechanically unexceptionable than those worked at high voltage.

I have spoken of the growth of a demand for power distributed in a convenient form in towns. The power distribution in London, Manchester, Birmingham, and Liverpool by pressure water, and that by compressed air in Paris, shows how rapidly, when power is available, a demand for it arises. A striking instance may be found in the small town of Geneva.

In 1871, soon after the completion of the earlier system of low-pressure water supply, Col. Turrettini applied to the municipal council to place a pressure engine on the town mains for driving the factory of the Society for Manufacturing Physical Instruments. The plan proved so convenient that nine years after, in 1880, there were in Geneva 111 water-motors supplied from the low-pressure mains, using 34,000,000 cubic feet of water annually, and paying to the municipality nearly £2000 a year. The cost of the power was not low. It was charged at a rate equivalent to from £36 to £48 per horse-power per year of 3000 working hours. But even the high price did not prevent the use of power so conveniently obtainable.

Since then a high-pressure water service has been established, the water being pumped by turbines in the Rhone. From this high-pressure service power is supplied more cheaply. On the high-pressure system the cost of the power is about 0·7*d.* per horse-power hour, or £8 per horse-power for 3000 working hours.

In 1889 the annual income from water sold for power purposes on the low-pressure system was £2085 and on the high-pressure system £4500. On the high-pressure system the receipts in 1889 were increasing at the rate of £880 per year.

In 1889 the motive power distributed, on the high-pressure system alone, amounted to 1,500,000 horse-power hours, there being seventy-nine motors of an aggregate working power of 1279 horses.

In Zurich there is quite a similar system and power, amounting to 9,000,000 horse-power hours in the year, distributed hydraulically to various consumers, who pay a rental of £1200 per annum. It will be noted that all this power in Geneva and Zurich is obtained from water which has been pumped, and it is the low cost of the water-power which does the pumping which makes this possible.

But, further, in both Geneva and Zurich the whole of the dynamos supplying electric light are also driven by turbines using pumped water. The convenience of this arises in this way. The fall obtainable in the river in both cases is a small one, and varies. Large turbines are required, and these cannot work at a constant speed. Further, it is expensive to use these large low-pressure turbines to drive directly dynamos which only work with a considerable load for a short portion of the day. The low-pressure turbines in the river are therefore used to pump water to a high-level reservoir, and they work with a constant load all the twenty-four hours.

From the high-level reservoir water is taken as power is required to drive the dynamos, and the turbines driving the dynamos are small high-pressure turbines, working always on a constant fall at a regular speed, and easily adjusted by a governor to a varying load. The system seems a roundabout one, but it is perfectly rational, effective, and economical.

Few persons can have seen Niagara Falls without reflecting on the enormous energy which is there continuously expended, and for any useful purpose wasted. The exceptional constancy of the volume of flow, the invariability of the levels, the depth of the plunge over the escarpment, the solid character of the rocks, all mark Niagara as an ideally perfect water-power station; while, on the other hand, the remarkable facilities of transport, both by steam navigation on the lakes and by four systems of railway, afford commercial advantages of the highest importance. From a catchment basin of 240,000 square miles, an area greater than that of France, a volume of water amounting to 265,000 cubic feet per second descends from Lake Erie to Lake Ontario, a vertical distance of 326 feet, in 37½ miles.

Supposing the whole stream could be utilized, it would supply 7,000,000 horse-power. This is more than double the total steam and water-power at present employed in manufacturing industry in the United States.

Immediately below the Falls the river bends at right angles, and flows through a narrow gorge. The town of Niagara Falls on the American side occupies the table-land in this angle.

The earliest traders who settled near the Falls erected stream mills in the Upper River in 1725 for preparing timber. Later, the Porter family erected factories on the islands in the rapids above the falls. It was not, however, till about thirty years ago that any systematic attempt was made to utilize part of the water-power of the Falls. Then a canal was constructed from Port Day, about three-quarters of a mile above the Falls, to a fore-bay or head-race along the cliff overlooking the lower river. In 1874 the Cataract Mill was established, taking power from this canal, and other mills were gradually erected till about 6000 horse-power were utilized. These mills have been exceedingly prosperous, but since the growth of a feeling against the disfigurement of the Falls it has become impossible to extend works of the same kind.

The idea of a method of utilizing the Falls, capable of greater development, and free from the objections to the hydraulic canal with mills discharging tail water on the face of the cliff, is due to the late Mr. Thomas Evershed, Division Engineer of the New York State Canals. He proposed to construct head-race canals on unoccupied land some two miles above the Falls. From these the water was to fall through vertical turbine pits into tail-race tunnels, converging into a great main tunnel, discharging into the lower river. Apart from an inappreciable diminution in the volume of flow over the Falls, this plan avoids any disfigurement of the scenery near the Falls, and permits a head of nearly 200 feet to be made available. It is, however, essential to such a plan that work should be undertaken on a very large scale. In 1886 the Niagara Falls Company was incorporated, and obtained options over a considerable area of land, extending from Port Day for two miles along the Niagara River. In 1889 the Cataract Construction Company was formed to mature and carry out the constructional works required.

The present plans contemplate the utilization of 100,000 effective horse-power. The principal work of construction is a great tunnel 7260 feet long, which is to form a tail-race to the turbines, starting from lands belonging to the Company, and discharging into the lower river. The tunnel is 19 feet by 21 feet, or 386 square feet in area, inside a brickwork lining 16 inches thick.

The base of the tunnel is 205 feet below the sill of the head gate, and permits a fall of 140 to be rendered available at the turbines. The brickwork of the tunnel is lined for 200 feet from the mouth with cast-iron plates.

The tunnel has been excavated with remarkable rapidity with the aid of drills worked by compressed air.

The main head-race, about 200 feet wide, will run for about 5000 feet parallel with the river, having entrances from the river at both ends. Near the lower reach the Soo Paper Company is already arranging to utilize 6000 horse-power, discharging the water from the turbines through a lateral tunnel into the main tunnel. Near this lower reach will also be placed two principal power stations, from which power will be distributed, either electrically or otherwise in ways not yet fully determined. The first turbines to be erected in these power stations will be twin turbines of the outward flow type of 5000 effective horse-power. These turbines have a vertical shaft for driving dynamos or other machinery placed above ground.

According to Mr. Evershed's original plans, it was intended to distribute water by surface canals to different power users, each of whom would sink his own turbine pits, connected below by lateral tunnels to the main discharge tunnel. Some of the power at Niagara will undoubtedly be used in this way, and in the case of industries requiring a large amount of power it will be economical to purchase a site and water rights.

Such a plan is, however, not adapted to smaller factories. Obviously for them it would be more economical to develop the power in one or more central stations by turbines of large size under common management. Further, once given the means of distributing power instead of water, an important extension of the project becomes possible.

Besides supplying power to industries which may locate themselves at Niagara, the power may be transmitted to the existing factories in Buffalo and Tonawanda.

Arrangements are already proceeding to transmit 3000 horse-power to Buffalo, a distance of 18 miles, to work an electric lighting station.

In 1890, Mr. Adams, the President of the Niagara Construction Company, visited Europe to examine systems of power distribution. It was in consequence of this visit that the important modification of the plans of the Company involved in the substitution, to a large extent, of a system of power distribution, for a system of water distribution came to be adopted. The American engineers were anxious to obtain the best European advice as to the methods best suited to the local conditions. A commission was formed, consisting of Lord Kelvin, Dr. Coleman Sellers, Prof. Mascart, and Colonel Turrettini, and an invitation was given to engineers and engineering firms in Europe and America to send in competitive projects for the utilization of the power at Niagara and its distribution to different consumers at Niagara and in Buffalo by electrical or other means. Many of the plans sent in were worked out with great care and completeness. As to the hydraulic part of the projects there was some approach to general consent as to the arrangements to be adopted, but as to the methods of distributing the power there was an extraordinary diversity.

Generally the Commission reported in favour of electrical distribution, with perhaps a partial use of compressed air as an auxiliary method.

Generally also they reported in favour of methods of distribution by continuous currents in preference to alternating currents. Since the date at which the Commission reported, the Frankfort-Lauffen experiment has been made, and in the opinion of some electrical engineers a distinct advance has been achieved in the use of alternating currents at high potential.

The Company has not yet decided to adopt any plan for the central stations except in a tentative way. One or more turbines of 5,000 horse-power are to be erected, and probably at first this power will be distributed to Buffalo by an alternating current system.

The cost of a steam horse-power at Buffalo is reckoned at 35 dollars per annum. I believe the Company will be able to deliver power at from 10 dollars for large amounts, and a greater price for small amounts, this price being reckoned for twenty-four hour days.

The new industry of electric lighting has made necessary the provision of large amounts of motive power. Electric traction similarly depends on the supply of motive power. New chemical and metallurgical processes are being introduced which entirely depend for their commercial success on the supply of motive power at a low price.

Niagara is likely to become not only a seat of large manufacturing operations of familiar types, but also the home of important new industries.

NOTES.

WE regret to have to announce the death of Sir Daniel Wilson, the President of Toronto University.

ALTHOUGH the sixth International Geographical Congress will not assemble in London until June, 1895, arrangements are already being made in connection with it. The organizing committee is not quite completed, and the Royal Geographical Society is still adding to it. Among those already nominated are the President of the Society (Sir Mountstuart Grant Duff), the honorary Secretaries of the Society (Messrs. Douglas Freshfield and Henry Seebohm), Sir George Bowen, Sir Charles Wilson, General J. T. Walker, Major Darwin, M.P., Mr. J. Scott Keltie, Sir Frederick Abel, Sir Henry Barkley, and General J. F. D. Donnelly. This committee is busily engaged in making its arrangements.

THERE has been a recrudescence in the eruption of Etna during the past week. We trust that there is a local successor to the lamented Prof. Silvestri to give us some day a complete history of the phenomena.

THE weather during the past week has been very unsettled, although during the first part the disturbances were mostly confined to the north. The anticyclone which had for some time lain to the westward of our islands moved southwards, and shallow depressions appeared off Scotland. The prevailing winds were consequently westerly or south-westerly, and temperature was rather above the average, except in the north and west, where the daily maxima were frequently below 60°, being some degrees lower than the average. On Sunday a rather deep depression from the Atlantic became central over our islands, accompanied by very heavy rainfall in Ireland and Wales, and rainy weather subsequently spread over the whole of the kingdom; while a considerable fall of temperature and strong northerly winds followed the passage of the depression to the eastwards. The report issued by the Meteorological Council for the week ending the 6th instant shows that the rainfall only exceeded the mean in the north of Scotland; in all other districts there was a deficit. The deficiency was greatest in the south-west of England, where it amounted to eight inches since the beginning of the year.

PROF. LOEFFLER, of the University, Greifswald, has published two articles in the *Centralblatt für Bakteriologie*, on his discovery of, and experiments with, the *Bacillus typhi murium*, and on the result of its application, at the request of the Greek Government, to arrest a plague of field-mice in Thessaly. In view of their scientific interest, these articles have been translated under the direction of Mr. Harting, and will appear in the next number of *The Zoologist*.

VON HELLMUTH PANCKOW contributes an article on the dwarf races in Africa and South India to the recent number of the *Zeitschrift der Gesellschaft für Erdkunde*.

A MOST important report of the sugar-cane borers, which do so much harm in the West Indies, from the pen of Mr. W. F. H. Blandford (Lecturer on Entomology, Cooper's Hill), appears in the *Kew Bulletin* for July and August.

THE *Monthly Weather Review*, of the Dominion of Canada, for April 1892 contains notices of aurora seen on almost every day of the month. The most widely-observed display occurred on the 23rd, 24th, and 25th.

THE *Abhandlungen* of the Royal Prussian Meteorological Institute (Bd. I., No. 5) contains a very elaborate investigation, 154 quarto pages, of the aspiration apparatus invented by Dr. R. Assmann, of Berlin, an instrument intended to determine the true temperature and humidity of the air under any conditions. The first apparatus of this kind was invented by Mr. John Welsh in 1853, and was used by him and also by Mr. Glaisher in their balloon ascents, after which time it appears to have been overlooked, or set aside, until it was again reinvented by Dr. Assmann, in a modified form, in 1889. We cannot enter into the construction of the apparatus here, further than stating that by the rotation of discs, the continual renewal of the air in connection with very sensitive thermometers is ensured, by which means sudden changes of temperature which cannot be followed by an ordinary thermometer are indicated. The apparatus is used at the Prussian Institute and at the German colonies in Africa as a standard instrument for the determination of the true temperature and humidity of the air. For ordinary stations however, or for observations at sea, we presume that it is not likely to come into general use.

THE report of the director of the Hong Kong Observatory for the year 1891 contains a table of the monthly and yearly rainfal value for about forty years. The mean yearly value is

90·17 inches, most of which falls between May and September. Dr. Doberck states that there is apparently a little more rain when there are many spots on the sun, but the difference is too slight to be of any practical importance. The east wind is most prevalent at all seasons, the colony being within the region of the trade wind; about 59 per cent. of all winds blow from this quarter, but from June till September there is also a southerly maximum, caused by the monsoon. In winter the temperature is highest with south, and lowest with north wind, and in summer it is highest with south-west, and lowest with east winds. During the year, 213 ships' log-books have been examined for data relating to typhoons, and registers have been regularly kept at about forty stations.

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus*, ♂ ♂) from India, presented respectively by Lieutenant H. S. Wilson and Mrs. Dunnington Jefferson; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. C. Carrington; an Angolan Vulture (*Gypohierax angolensis*, juv.), a —— Buzzard (*Buteo* ——) from West Africa, presented by Dr. Ferrier; a Spiny-tailed Mastigure (*Uromastix acanthinurus*) from Algeria, presented by Lady Sebright; a Black-headed Caique (*Caica melanocephala*) from Demerara, two Spiny-tailed Mastigures (*Uromastix acanthinurus*) from Algeria, deposited; three Short-headed Phalangers (*Belidens breviceps*) from Australia, a Hairy Armadillo (*Dasypus villosus*, ♂) from La Plata, a White-throated Capuchin (*Celeus hypoleucus*, ♀) from Central America, four Scarlet Ibises (*Eudocimus ruber*) from Para, purchased; a Testaceous Snake (*Ptyas testacea*) froms California, received in exchange.

OUR ASTRONOMICAL COLUMN.

NATAL OBSERVATORY.—The superintendent of the Nata Observatory, in his report for the year 1890–91, tenders hi obligations to no less than seven ladies, without whose zealou assistance, he says, the greater part of the numerous astronomica computations, &c., would not have been carried out. Although lacking such aid as is consistent with the proper working of an Observatory, a great amount of very useful work has been accomplished. For instance, the entire mass of meridian observations of the moon made at Greenwich during the period 1851–1861 have been reduced and compared with the theoretical basis of Hansen's Lunar Tables, thus completing the whole number of lunar observations up to the year 1890. The work with the transit, magnetic transit, and equatorial have been continued as usual. For the determination of the latitude of the Observatory 1022 observations of thirty-five pairs of stars have been obtained. Owing to the close proximity of the equatorial and transit instruments, we are informed that it is impossible to use them both at the same time; this should be at once remedied, for the Observatory does not seem to be supplied with many surplus instruments.

The meteorological observations have been made regularly throughout the year. We hope, now that provision has been made for supplying a rain gauge and set of thermometers for each of the coast magistracies, that the Observatory will still continue to urge the necessity of maintaining and extending the system of weather reports, in the interests of the Colony, for, as is now well known, the value of such observations is only maintained when the stations are *numerous* and well *distributed*.

GEODETIC SURVEY OF SOUTH AFRICA.—Since the issue of the last (Jan. 1891) report by H.M Astronomer, Dr. Gill, on the Geodetic Survey carried on in South Africa, the work has been progressing very successfully and swiftly, an average of five principal stations being occupied and completed every month by a single observer. On May 31, 1891, the field work as far as Modder River was completed, the site for the base line being reached the following day. Some difficulty was here encountered with regard to the selection of the position for the base, but it was eventually fixed near Kimberley, the permanent camp being fixed about eight miles from this place. The total length of the measured base was 6000 feet, and it was divided into sections of 500 feet, since this seemed "a convenient length for a forward and backward measurement in one day." The figures given in this report, although uncorrected for sea-level, &c., speak well for the accuracy of the undertaking, as will be seen from the following table. Each length of 500 feet was measured both forward and backward, and it is the differences of these measurements that are here shown:—

Section.	F − B in feet.	Section.	F − B in feet.
I.	+ 0·0025	VII.	+ 0·0014
II.	− ·0020	VIII.	+ ·0011
III.	− ·0006	IX.	+ ·0014
IV.	− ·0040	X.	+ ·0009
V.	+ ·0019	XI.	+ ·0028
VI.	− ·0019	XII.	+ ·0015

The probable error of the whole base was ± 0·028 inches. The lengths of the two sections came out as—

M_i = 2999·4445 feet
M_{ii} = 2999·7545 „

The differences between the measured and the computed lengths of Section II. through the triangulation were: by the eastern triangles $M - C_1 + 0{\cdot}0035$ feet; by the western triangles $M - C_1 - 0{\cdot}0083$ feet.

During the triangulation work several observations for latitude were made at Tafelberg, Hanover, De Put, and Kimberley Camp, the results showing, as Dr. Gill points out, "that the abnormal deviation of the plumb line found along the coast in the neighbourhood of Port Elizabeth had disappeared." The report concludes with the determinations of the observers' personal equations and two diagrams of the triangulation.

THE INTERNATIONAL CONGRESS OF EXPERIMENTAL PSYCHOLOGY.

WHEN the first Congress on this subject met in Paris in 1889 under the presidency of Prof. Ribot, and with Prof. Charles Richet for its secretary, it proved a vigorous and most successful attempt to gather together from all parts of the world the students of a difficult branch of learning in which some methods of modern physics are being used in psychology, and these methods, or at least their results, are invading the province of what our ancestors would have preferred to call metaphysics. In the opinion of many of the most thoughtful students of the subject it has been considered an important point to keep up the connection between the physiological and the psychological sides of the questions under discussion, and the present Congress under the careful and admirable presidency of Prof. Henry Sidgwick, has proved very successful on this point, and has led to much pleasant acquaintanceship between those whose general work lies in different branches of learning. At Paris the full number at the Congress was about 150, and very little notice was taken of it in England; but at this recent Congress in London there have been nearly twice as many members, and it has received 70 or 80 visitors from all parts of Europe and from the United States and Canada. The vice-presidents have been Prof. A. Bain, Prof. Baldwin, Prof. Bernheim, Prof. Ebbinghaus, Prof. Ferrier, Prof. Preyer, Prof. Delboeuf, Prof. Liégeois, Prof. Preyer, Prof. Richet, and Prof. Schäfer. Among the other well-known names of the visitors there were those of Helmholz, Binet, Ribot, Henschen (Upsala), Münsterburg (Freiburg), and among the English names Herbert Spencer, Francis Galton, Prof. Oliver Lodge, Prof. Victor Horsley, Dr. Lauder Brunton, and Dr. Hughlings Jackson. The honorary secretaries were Prof. James Sully and Mr. F. W. H. Myers. The rooms of University College were kindly lent to the Congress by Mr. Erichsen for its use during the four days of the meeting (Aug. 1-4). Prof. Sidgwick's address attracted a large audience. He expressed himself as feeling it his first duty to apologize for the choice of England as the place of meeting, inasmuch as England could not be said to be the country which had done most for experimental psychology which, in the common meaning of the terms, had been most advanced in German and French laboratories, and was making recent and rapid progress in America. However, in a slightly different sense of the word the English school of psychologists from Locke and Hume down to Bain and Herbert Spencer had been for the most part experimentalists or at least empiricists. They had before them at this Congress a very wide range of subjects, too extensive he thought on the whole to be covered by the term "Psychologie Physiologique," which had been used at Paris as the name of their first Congress, and he thought "Experimental Psychology" more appropriate. In laboratory work the leadership was taken by Germany; in hypnotism France was our master and Germany our colleague. He was glad to see some of the leaders of the Nancy School with them that day, as he thought they were taking the broader lines in the subject, and that Europe was certainly not inclined on the whole to narrow the subject. He would not attempt to discuss the larger questions at that time, but would confine himself to the harmless task of explaining the arrangements that were proposed. In the morning meetings the Congress would be divided into two sections, of which Section A would be devoted to neurology and psycho-physics, and Section B to hypnotism and cognate questions; in the afternoon there would be general meetings.

The address was very warmly received, and Prof. A. Bain, in reading the first paper took the opportunity of expressing his gratitude to Prof. Sidgwick and the secretaries for the energy they had shown in bringing together such a large group of men who were glad to make each other's acquaintance. He went on to read an interesting paper on the advantages in psychology of introspection on the one side and experiment on the other, and the ways in which one could help the other. Prof. Charles Richet went on to discuss some of the possible prospects of psychology, and to express a hope that some of the most difficult subjects, such as thought-transference and clairvoyance, might be helped by the minute study of the process of development of the human mind. Prof. Gruber (of Roumania) then gave a very vivid sketch of the remarkable association of colour with sound, which he had spent many years in observing. To a very small number among his best educated patients the sound of the vowel "e" was accompanied by a sensation of yellow colour, of "i" by blue, of "o" by black, and so on through the long list of the Roumanian vowels and diphthongs, and also to some extent with numbers. The same colour was not always induced by the same sound in different patients, but the observations had been carefully tested. Prof. Pierre Janet related in detail a long case of complete loss of memory for present events and complete incapacity for any decision (*l'aboulie*) which had been suddenly brought about by the foolish jest (on August 28, 1891) of telling her what was not true, viz. that her husband was dead. The most curious points were that the loss of memory extended backwards as far as July 14, 1891, *i.e.* of what had happened during the six weeks before the accident, though the natural memory was complete up to July 14, and the patient's sub-conscious memory of all that had happened after that could be easily demonstrated by her automatic writing and by unconscious speech in a normal or hypnotic sleep. Prof. Ebbinghaus, in criticizing the paper, remarked that the woman's state seemed best explained as a condition of such complete distraction by things without that she had no power to attend to things within. Mr. Myers cited a case described by the elder Despine in 1830, in which there was a description of double memory and double personality such that the woman in the second state could eat and drink like a drayman, but soon reverted with no memory to her first state, and asked pitifully for her usual four teaspoonfuls of arrowroot.

Next day Section A and Section B went to work separately. In Section A Prof. Henschen (Upsala) read a paper which attracted considerable attention and consisted in a very careful examination of the exact tract of the visual path in man through the brain from the eye to the visual centre in the cortex of the calcarine fissure. It was admitted that it was not in accordance with the results of physiological experiments on animals; but the arguments for its proof in man were considered quite sufficient. Prof. Horsley followed with a paper on the degree of Localization of movements and correlative sensations, which roused some discussion; and then Prof. Schäfer brought forward careful experiments to show that there was no valid reason to attribute any intellectual powers to the prefrontal lobes of the brain; and Dr. Waller ended the work of the morning by illustrating the difficulties of accurately defining the functional attributes of the cerebral cortex.

In Section B Prof. Liégeois read a paper which M. Liébeault, of Nancy, had written along with him describing a case of suicidal monomania, which they had succeeded in curing by hypnotic suggestion. The President expressed himself much interested in the paper, and regretted that they could not see Liébeault among them, for he was a man who, after twenty-five years of contempt, had succeeded in making the world realize some new methods. Dr. Frederic van Eeden (Amsterdam) read a careful report of his five years' experience of the medical cases of hypnotism along with Van Renterghem in Amsterdam. He laid stress on the care which should be taken to avoid the distrust and prejudice caused by the abnormal facts of hypnotism in public exhibitions. With the upper classes he thought hypnotism more difficult than with the lower, for they objected, rightly, to a tone of command. Psycho-therapy with them must guide and support, but not command, and that it would do so even to the extent of curing some organic disease he regarded as well proved. Virchow's cellular pathology had neglected the psychical forces of the living cell. Now that these were acknowledged some principles of the old vitalism must revive. Prof. Bernheim read another more technical paper on hysterical amaurosis, explaining it as a purely psychical state brought about by suggestion, with which Dr. Bérillon could not agree, but Prof. Bernheim replied that there was nothing abnormal in hypnotism; there was no difference between normal and hypnotic sleep, though the two states were produced by different means. Further, there was not necessarily any sleep in hypnosis. It was a pity for that reason that the word had been chosen, for hypnotism meant simply suggestibility. Prof. Delboeuf took a similar view; to hypnotize a man was only to persuade him that he could do something that he thought he could not do. Supposing the man thought he had a pain, to hypnotize him was to make him sure he had not. Dr. Bérillon preferred to define hypnotism as the psychical state in which the cerebral control had been taken away artificially, and the patient became an automaton for any use. Such automatism was not in any way necessarily injurious to the subject, and was certainly useful in some diseases.

In the general afternoon meeting there were elaborate theories of colour perception well explained to the Congress both by Prof. Ebbinghaus and by Mrs. C. L. Franklin; and Prof. Lloyd Morgan attempted the difficult task of defining the limits of animal intelligence, chiefly as shown by the dog, whom he was sorry not to be able to credit with as much power of introspection as many of his friends. After some slight discussion on this, Dr. Bramwell (of Goole) brought forward four subjects from Yorkshire, on whom he showed some of the common phenomena of hypnotism and related some of his experiences in recent medical practice, which he had been able to show to doctors in Leeds and elsewhere, *e.g.* that he had been able in a few cases to produce by hypnotism, at a time when the patient seemed fully awake and normal, a state of local anæsthesia to allow a dentist to extract seven double teeth without any pain to the patient.

On Wednesday morning, in Section A, Prof. Heynaus (of Copenhagen) read a paper on the relation of Weber's law to the phenomena of the inhibition of presentations; Dr. Mendelssohn (St. Petersburg) on the parallel law of Fechner; Dr. Verricst (Louvain) on the physiological basis of rhythmic speech; and M. Binet (Paris) on the psychology of insects, showing that in the Coleoptera the dorsal nervous centres were motor and the ventral sensory. In Section B Prof. Delboeuf pointed out the remarkable power of the somnambulist in judging of the length of passing time without any watch or instrument. He had found some simple Belgian countrywomen when hypnotized able to carry out suggestions at any time he liked to name from 300 to 3000 minutes, and he thought the subject deserved further inquiry. Prof. Hitzig (Berlin) brought forward a minute and careful physiological study of some attacks of sleep which had some resemblance to hypnotic conditions.—Mr. F. W. H. Myers showed from the reports drawn up by Mr. Kenlemans, Mrs. Verrall, and two other experimenters of some experience that in some cases, though probably only in a few, it was possible to induce hallucinations by such an experiment as crystal vision, *i.e.* the purely empirical process of looking steadily into a crystal or other clear depth or at a polished surface. These externalized images or quasi-percepts illustrated some little known points in conscious and sub-conscious memory. Prof. Pierre Janet corroborated Mr. Myers's results by some of his own, in which, for instance, dreams which had been manifest to the onlooker but unknown to the sleeper were brought within the sleeper's knowledge by gazing on a bright surface or by the essentially similar process of automatic writing. In the afternoon the President presented a very long report of careful detail of a census of hallucinations which had been agreed upon at the Congress in Paris in 1889, and which had been carried out in England by himself, in America by Professor William James, and in France by M. Marillier. The question asked in England had been, "Have you ever, while in good health, and believing yourself to be awake, seen the figure of a person or heard a voice which was not in your view referable to any external cause?" In England 17,000 answers had been obtained, and about 1 in 10 persons (taken at random) who had answered had had some such hallucination in their lives. The great majority of these hallucinations consisted of realistic appearances of living men, a small minority of dead persons, and a still smaller group of grotesque objects. A remarkable class was that of hallucinations of several persons at one time—collective hallucinations; and a still more remarkable class was of those coincidental with some distant event unknown to the percipient, such as the death of the person whose figure appeared. The President came to the conclusion that after careful allowance for all sources of error, the probability against these coincidences being chance was enormous, and if the hypothesis that they were not casual was to be accepted, the assumption of the inaccuracy of the informants and inquirers must be strained to an extreme pitch. M. Marillier explained that it had been very difficult to get any large number of answers in France because of the dislike shown by the French to answer any psychological questions about themselves.

On Thursday morning, in Section A, Dr. Donaldson gave an interesting account of the minute investigation of the brain of Laura Bridgeman, the well-known blind deaf mute, who died in 1889 in Boston. There was depression of the motor speech centre, with slender sensory nerves and somewhat thin cortex over the areas of the defective senses. In Section B Dr. Bérillon raised a lively debate by describing the good effects he had brought about by hypnotism in the education of about 250 children, who were suffering from many childish discomforts, such as night-terrors, insomnia, somnambulism, or faults, such as kleptomania, idleness, cowardice, &c. After this Mrs. H. Sidgwick gave a summary of some experiments in thought-transference she had made, with the help of Miss A. Johnson and Mr. G. A. Smith as hypnotiser. By thought-transference she meant the communication from one person whom they called the agent to another, whom they called the percipient, otherwise than through the recognized channels of sense. The successful percipients were seven in number, and had generally been hypnotised. They had succeeded in transferring numbers, mental pictures, *i.e.* mental pictures in the agent's mind, and induced hallucinations given by verbal suggestion to one hypnotic subject, and transferred by him to another. In the total number of experiments the number of failures was much larger than of successes, but as the antecedent probability could in most cases be accurately determined, the proportion of successes was amply sufficient to show that the result was not due to chance. The many precautions necessary to such experiments were described in detail. One percipient succeeded in the experiments with numbers when divided from the agent by a closed door at a distance of about 17 feet. Attention was called to the great variability of results with the same percipients and agents for which they had not been able to discover any reason. An account was added of some experiments in producing local anæsthesia under conditions apparently excluding all suggestion other than mental. The President wished to remark that he thought it important in such experiments that all the failures should be recorded as well as the successes. In the afternoon, after papers by Dr. Lightnar Witmer, Dr. Wallaschek, and Prof. von Tschisch, the President put several questions to the vote as to matters of future organization, and it was decided to hold the next international Congress in Munich in 1896, with Prof. Stumpf as President and Baron von Schrenck as secretary. A suggestion was also made that there should be an extraordinary meeting in America next year, and a small American committee was appointed to consider this. After a hearty vote of thanks to the President and Secretaries, and a brief reply, the Congress was dissolved.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 1.—M. de Lacaze-Duthiers in the chair.—On boron pentasulphide, by M. Moissan. If the tri-iodide of boron, instead of being treated with sulphur in the dry way at a low red heat, as in the preparation of boron trisulphide, be mixed with sulphur and dissolved in carbon bisulphide at the ordinary temperature, boron pentasulphide is obtained. It fuses at 390°, and does not pass through the pasty state. In contact with water it forms boric acid, sulphuretted hydrogen, and a precipitate of sulphur. Mercury and silver reduce it to the trisulphide, forming metallic sulphides. Heated to fusion in a vacuum it decomposes into sulphur and the trisulphide. Its density is 1·85. It is very difficult to obtain free from iodine, but in all the preparations the ratio between the boron and the sulphur has indicated the formula B_2S_5.—On the stripped plants of autumn, and their utilization as green manure, by M. P. P. Dehérain. It has been found that by planting the ground with vetch or mustard, and digging it in during the autumn, the amount of nitrogen retained in the soil was nearly doubled.—Remarks on alimentation in the Ophidia, by M. Léon Vaillant.—A report on the great anaconda of Central America kept in the reptile menagerie. Since 1885 the snake has eaten on the average five times per annum, its nourishment consisting of goats, three rabbits, and one goose. The interval between two meals was in one instance 204 days.—On symmetric tetrahedral curves, by M. Alphonse Dumoulin.—On Stokes' law, its verification, and interpretation, by M. G. Salet.—A spectrum, given by a spectroscope with quartz prisms, is received on the fluorescent substance contained in a Soret eye-piece. It is then projected transversally on to the slit of a second spectroscope. Through this the diagonal spectrum of Stokes' classical experiment is seen with perfect definition, no ray exceeding the theoretical limit. The law thus verified can also be deduced from thermodynamic considerations. According to Stokes' law, "the rays emitted by a fluorescent substance always have a smaller refrangibility than the exciting rays." If it were possible to transform yellow into violet light by fluorescence, many chemical reactions would become possible which only occur at the higher temperature at which violet appears in the spectrum. This would be equivalent to the passage of heat from a colder to a hotter body, in contradiction to the second law of thermodynamics.—Constitution of pyrogallol, by M. de Forcrand.—On Cascarine, by M. Leprince.—Physiological examination of four cyclists after a run of 397 km., by MM. Chibret et Huguet. This distance, which was covered by the youngest of the party, an Englishman of 18, in seventeen hours, was that between Paris and Clermont-Ferrand. It was found that the temperature was at the finish rather below than above the normal; that the coefficient of utilization of urinary nitrogen varied inversely as the degree of fatigue, and that therefore a decided waste of nitrogen is a concomitant of excessive fatigue. The nutriment taken during the course consisted of much alcohol, champagne, beef-tea, and Kola solution in the case of the Englishman. He and the next in speed both took Kola. The winner was extremely fatigued at the finish; the next man, a Frenchman of 28, not at all. His pulse was beating at 60, that of the former at 84. The coefficients of utilization of nitrogen were 76·32 and 58·27 per cent. respectively.—On the properties of the vapours of formol or formic aldehyde, by MM. F. Berlioz and A. Trillat.—Subcutaneous grafting of the pancreas: its importance in the study of pancreatic diabetes, by M. E. Hédon.—On the habits of *Clinus argentatus* Cuv. and Val., by M. Frédéric Guitel.—On a Permian Alga, with its structure preserved, found in the boghead of Autun: *Pila Bibractensis*, by MM. C. Eg. Bertrand and B. Renault.—The chalk of Chartres, by M. A. de Grossouvre.

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THURSDAY, AUGUST 18, 1892.

A DEBATABLE LAND—PLANTS OR ANIMALS?

A Monograph of the Myxogastres. By George Massee. (London: Methuen and Co., 1892.)

THIS work is much in advance of any book in the English language treating of the perplexing group of organisms that forms its subject. The author has been in peculiarly favourable circumstances for the preparation of such a monograph, having enjoyed full access to "the splendid collection of Myxogastres in the Royal Herbarium, Kew, rich in types, and with numerous annotations by Rostafinski," as well as had "the loan or gift of valuable, and in some instances unique, specimens" from other workers in the same field in different countries. He has fully acquainted himself with the literature of the subject, and has made many personal observations on the structure, and, in some cases, on the life-history, of various types. He is thus able to bring to bear on the discussion of the problems that claim consideration a wide and varied knowledge; with the result that the book is indispensable to every student of the Myxogastres. The introductory portion will be found worth perusal by others besides specialists, as it discusses the arguments for and against the vegetable nature of the group. While accepting the view that the origin of the Myxogastres is to be found among the *Flagellatæ*, he comes to the conclusion that the sum of the characters presented by them in the reproductive phase manifests a tendency "in the direction of the vegetable kingdom, and more especially in the direction of the Fungi." But he is unable to establish strict homologies with the latter; since the Myxogastres are "a terminal group, and permit no comparisons with higher forms of the same type." In the discussion of this vexed question, Mr. Massee shows none of the virulence to which it has given rise in former times; and he endeavours to do justice in his statement to the views of De Bary, and of other supporters of the view that the organisms in question should be regarded as animals. After all, to an evolutionist at least, the distinction would appear more of verbal than of real importance.

Accepting the view that there are certain forms, of a very primitive structure, from which the animal and vegetable kingdoms have been developed in ever-increasing specialization, there is cause to expect the existence of more or less intermediate types, in which the characters at one period of their life-history are more those of animals, and at another period more plant-like. It matters little under which kingdom we agree to place them. Here, as elsewhere, Nature refuses to be bound down by rigid classification, and we must accept facts as they are, not as any *a priori* system might wish to make them. That the Myxogastres are not Fungi may be admitted; though they show a considerable similarity in various points in the course of development—a similarity clearly stated by Mr. Massee in his discussion of the whole question.

The term *Myxogastres* is employed, we infer, on the ground of priority. It possesses, however, the incidental advantage of not implying any positive view on the nature of the group, in the same way as do the terms *Myxomycetes* and *Mycetozoa*. The limits of the group are taken in this monograph in the sense employed by Rostafinski. It thus does not include the *Acrasieæ* and *Ceratium*, admitted as Mycetozoa by De Bary; nor does it make any reference to the numerous forms of the *Monadineæ*, which Zopf discusses in his "Schleimpilze" in Schenck's "Handbuch der Botanik." Thus limited, the group is more homogeneous; though the definition is, perhaps, somewhat arbitrary, and omits forms that are undoubtedly related to the more specialized types, and an English work on which would be welcome.

The author enters on somewhat slippery ground in the endeavour to explain the line of development of the Myxogastres, and also to illustrate his ideas of the relationship between the several orders. He holds that four orders can be distinguished by the presence or absence of lime in the sporangial wall, and by the presence and nature of the capillitium.

> "In each order we find the special characteristic idea evolving through a sequence of genera, the terminal one not connected with any higher order, hence the special feature terminates abruptly within the order where it originated, and it is invariably in some comparatively undifferentiated genus near the initial point of each order, that we meet with the suggestion of a new line of evolution, which, at its maximum of development, constitutes the characteristic feature of the order immediately in advance of the one from which it emanated in an incipient condition."

Turning now to the systematic portion of the work, we find that it gives abundant proofs of care and of familiarity with the several forms, based on personal examination of each. The method of description is clear, the more important characters being printed in italics. Mr. Massee recognizes fully the difficulties of determining the limits of species and of the larger groups "while the life-history of the majority of forms is still unknown," saying plainly that

> "all attempts at classification, as also the conception as to what constitutes a species, must be considered as tentative. When we are better acquainted with the main lines of development and lines of variation, also the conditions determining these variations, it is certain that the main factor in the discrimination of species will not be a one-twelfth oil-immersion objective."

Basing his acquaintance with the Myxogastres on personal examination of large numbers of examples, fresh and dried, many of the latter being authentic types, Mr. Massee does not hesitate to unite species and genera hitherto kept as distinct, but shown to be connected by fuller material. Thus several familiar names become sunk as synonyms; *e.g. Licea*, Schrad., and *Lindbladia*, Fr., are ranked under *Tubulina*, Pers. (emended). Under the generally accepted rules of nomenclature, this leads to Massee standing as the authority for many species, transferred by him, in reality, to another genus. But, besides such cases of apparent novelties, there are also a good many descriptions of *new* species in the usual sense of the term. The synonyms are carefully given under each group and species. A wise reticence has been observed in the endeavour to recognize the species meant by most of the older writers who mention the Myxogastres. The synonymy previous to Rostafinski's monograph is borrowed as a whole from that work, "without any attempt at corroboration." Mr. Massee says:—

> "I feel certain that nearly one-third of Rostafinski's work would not have been sacrificed to synonyms unless they mean something more than I have been able to discover, hence I have not felt justified in ignoring them altogether."

The geographical distribution has been worked out from the extensive collections already referred to as at the author's command.

The twelve plates, bearing 313 coloured figures by Mr. Massee himself, call for special mention as a valuable assistance to students of the Myxogastres. They deserve high praise for their accuracy and execution. The printing and get-up of the book are very satisfactory. A review would scarce be complete did it not find fault with some point or other; and we may do that part of our duty very briefly by taking exception to the rather inconvenient size (large octavo), and to the tendency in the introductory pages to let the sentences run to an inconvenient length. One, taken at random, we found to occupy twenty-five lines. There is no ground for this charge, however, as regards the descriptive portion of the monograph.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Apodidæ—a Reply.

PROF. LANKESTER'S review of my book in NATURE (p. 267) contains, as is usual with "candid opinions," a considerable number of misstatements. These compel me to ask space for a reply.

Prof. Lankester commences by stating very authoritatively that my account of the hermaphroditism of Apus is erroneous. This question, being purely a matter of evidence, can wait. My account of it in "The Apodidæ" is "meagre" because, as is clear to any one who reads the preface, I was constrained to put aside for the present all questions which did not directly bear upon the line of argument embodied in my book.

These points, however, are not serious. Let us turn, then, to the main charges which are intended to deprive my book of all claim to be a real contribution to zoological science. Prof. Lankester, after himself dethroning my title, "The Apodidæ," says that I "pose as the discoverer of a new and unsuspected agreement between the Crustacea and the Chætopoda, and that I bring forward arguments as new which have "long been effectively used" for the same purpose. It is difficult here not to accuse Prof. Lankester of deliberate misrepresentation. If he will allow me to keep my title and will read my book, he will find that I go beyond this general standpoint, and specialize the Apodidæ as the particular Phyllopods which are to be deduced from a Chætopod. Without, I believe, a single page of digression, my book discusses from beginning to end the relation of the Apodidæ to the Annelids, of the Apodidæ to Limulus, to the Trilobites, and so on. All the well-known arguments in favour of the more general proposition which deduces the Phyllopods from Annelids I have naturally adopted, adding, however, many new arguments of more or less weight in favour of my special point. Not one of these arguments does Prof. Lankester attempt to meet. The only one he refers to he wishes to claim as his own, as, indeed, he does everything else in the book "which will bear examination"! This charge of wholesale plagiarism from Prof. Lankester's articles on Apus and Limulus is the more remarkable, because my own investigations compelled me either to modify or to reject almost every position therein adopted by him. This may account for his "candid opinion," but hardly for his charge of plagiarism. The only evidence he adduces to support this charge can merely be meant to throw dust in the eyes; it is as follows:—

In describing the absence of articulations in the limbs of Apus I admitted that Prof. Lankester had noted the point (which, however, is not absolutely correct), but I added that he had failed to see its significance. Prof. Lankester resents this statement, and cites himself to show that he agreed with Claus in holding that the limbs of the Arthropoda were homologous with the parapodia of the Chætopods. This acquiescence in a general proposition does not in any way prove that he applied it to explain the special conditions of the limbs of Apus.

While I do not at all share his jealousy in matters of priority, and will gladly yield the point to him if he can base his claim on something more definite than the passage he cites, the fact that he wishes to claim this argument for his own is specially interesting. There is far more meaning in this than in his use of such expressions as "fanciful conceptions, crude speculations, and dogmatic assertions," because, if this particular argument holds—and Prof. Lankester would not claim it unless he acknowledged its validity—it goes far to show that my theory can hardly be called a "fanciful conception." The reviewer's statement that "there is no evidence" that I "made use of well-preserved material," looks as if he had not taken the trouble to read the book, and further as if he did not understand the importance of the issues at stake; the histological points, which are the only ones likely to be affected by the state of preservation of the material, are insignificant as compared with the main argument.

If, instead of indulging in such loose charges, Prof. Lankester had endeavoured to show where, in his opinion, my argument breaks down, and what are some of the more glaring misstatements in my book, which cause him to "regret" that he cannot recommend it as "a repository of fact," he would have done science (and perhaps (?) myself personally) much better service. I should also personally have been grateful to him had he himself set an example to the more "inexperienced" zoologist of "how morphological problems should be attacked." I did not, in my speculations as to the relation of Apus to the Annelids, feel inclined to follow the example set by Prof. Lankester in his own speculations as to the relations of Limulus to the Arachnids. I was especially recommended to ripen my ideas, and to publish them together in book-form. Would Prof. Lankester have advised me to publish my speculations, as he did his, in separate articles, occasionally, perhaps, advancing theories and arguments in one article which have to be withdrawn in the next? This plan may be convenient for the writer, but is most annoying to all who have to work over the same ground again.

To conclude, my book is an argument from beginning to end; the argument may be absurd, but it must be met by argument. In the meantime, until Prof. Lankester demolishes it, I have the good fortune to know that several leading zoologists, among whom Prof. Haeckel kindly permits me to mention his name, think it—well, to say the least—*not* absurd.

August 2. HENRY M. BERNARD.

Calculation of Trajectories of Elongated Projectiles.

(*Additional Note.*)

IT has been already pointed out (NATURE, March 1892, p. 474) that the range table of the 4-inch B.L. gun, selected by the authorities, afforded a more satisfactory test of the value of the coefficients of resistance than the results of the special experiments carried out with that gun in 1887. This range table was based on practice of 17/5/83, 7/3/84, and 21,23/4/84. The muzzle velocity was 1900f.s.; the weight of the shot 25lbs.; and the diameter of the shot 4in. But no information is given respecting the height of the barometer or thermometer. In this table the elevations are given at which the gun must be laid to obtain ranges of 100, 200, 300 . . . . 7600, 7700 yards, and also the time of flight for each range, expressed to the $\frac{1}{100}$th of a second for ranges below 5000 yards, and to the $\frac{1}{10}$th of a second for ranges 5000 to 7500 yards.

In calculating the ranges for elevations of 1°, 2°, 3° . . . . 20°, the temperature was supposed to be 62° F., and height of the barometer 30in., at the level of the gun. The coefficient κ was supposed to be 0·97 to adapt the tables to a head struck with a radius of two diameters.

By the use of the range table it was found what was the experimental elevation and time of flight for each of the ranges obtained by calculation.

The results of calculation and experiment are given in the following table. In column 1 the calculated ranges are specified. In columns 2 and 3 the calculated and experimental corresponding times of flight are given, and in column 4 the differences of these quantities. In columns 5 and 6 the calculated and the experimental elevations are given, and in column 7 their differences, which are due to the "jump" of the gun and to the "vertical drift" of the elongated shot. The calculated horizontal remaining velocity (column 8) is given in each case in yards per second to facilitate the expression of the small errors in time, given in column 4, in yards of range.

By the use of the general tables the time of flight over each range and the horizontal remaining velocity have been calculated (see columns 10 and 9), supposing the shot in each case to start with the horizontal muzzle velocity, and to move through air of a density corresponding to the mean height to which the shot actually rises.

Range.	Time of flight.			Elevation.			Calculated horizontal remaining velocity.	General tables	
	Calc.	By R. T.	Diff.	Calc.	By R. T.	Diff.		Rem. vel.	Time.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Yards.	Secs.	Secs.	Secs.	°	° ′	′	y. s.	y. s.	Secs.
1053	1·92	1·90	+0·02	1	0 52	+ 8	479	478	1·92
1831	3·72	3·77	−0·05	2	1 56	+ 4	391	390	3·73
2433	5·36	5·44	- 0·08	3	2 58	+ 2	343	345	5·38
2937	6·86	7·00	−0·14	4	3 56	+ 4	322	322	6·89
3386	8·30	8·41	−0·11	5	4 53	+ 7	305	304	8·33
3797	9·64	9·77	−0·13	6	5 51	+ 9	293	289	9·73
4148	10·95	11·04	−0·09	7	6 44	+16	278	278	10·98
4467	12·21	12·23	−0·02	8	7 35	+25	265	268	12·15
4813	13·46	13·57	−0·11	9	8 36	+24	258	258	13·48
5110	14·66	14·74	−0·08	10	9 33	+27	249	250	14·66
5384	15·84	15·84	0·00	11	10 28	+32	242	242	15·81
5664	17·01	16·95	+0·06	12	11 25	+35	234	235	16·98
5924	18·14	18·10	+0·04	13	12 20	+40	227	228	18·12
6170	19·29	19·18	+0·11	14	13 12	+48	220	222	19·24
6398	20·40	20·29	+0·11	15	14 5	+55	214	217	20·30
6632	21·53	21·46	+0·07	16	15 0	+60	208	212	21·41
6821	22·58	22·51	+0·07	17	15 46	+74	203	207	22·34
7003	23·62	23·52	+0·10	18	16 33	+87	198	203	23·26
7221	24·75	24·71	+0·04	19	17 33	+87	192	199	24·38
7483	25·94	26·10	−0·16	20	18 47	+73	188	193	25·75

The very small differences in column 4 between the calculated and experimental times of flight for the full extent of the range table afford conclusive evidence of the accuracy of the coefficients of resistance derived from my experiments of 1867, 1868, and 1878–80.

F. BASHFORTH.

A Plea for an International Zoological Record.

BEING now for the second year one of the Recorders for our English "Zoological Record," I should like to offer a few remarks upon the disadvantages of the system of recording that prevails at present in England and abroad.

The first point to be noticed is the number of independent Records that are published. Chief among these are our *Zoological Record* and the *Zoologischer Jahresbericht*, published by the Zoological Station at Naples. Besides these there are several minor semi-private records which it does not concern us to enumerate.

The disadvantage of so many records is obvious. In the first place they are expensive, as the result of competition is to decrease the number of purchasers of each record, since comparatively few zoologists are able to purchase more than one of them. Secondly they are all in some way incomplete. Thus without going into great details it may be pointed out that the *Zoological Record* specializes upon systematic zoology, and as a result the portions devoted to animal morphology and embryology are all but useless, as a rule, to those interested in these subjects. Moreover, the systematic portion, being often undertaken by zoologists who are not professed systematists, does not appear always to give satisfaction to those it is intended to benefit. On the other hand the *Zoologischer Jahresbericht* leaves out systematic zoology entirely, which in many groups of animals cannot well be separated from other branches of study, and from the fact that it does not record palæontological papers, there are often omitted, at least in my two groups—sponges and echinoderms—many works of great morphological importance.

Some years ago a proposal was made by Dr. Dohrn and the staff of the Naples Zoological Station to unite the two records into one. The English part was to be entirely systematic, the Naples part was to be entirely morphological and physiological, and both were to be published together as parts of one record. This most excellent proposal was refused by the British zoologists, owing, apparently, to a desire to gain exclusive honour for British nationality.

I wish now to propose that this long-delayed project should be carried out, and that in future one International Zoological Record should be published. Such a record should fall into two natural parts: (1) a morphological and physiological part, and (2) a systematic part; each with its own chief editor. Seeing now that Naples is a recognized centre for zoological research, and that a modern zoologist's education is scarcely complete until he has studied there, the first part of the Record could best be done there much on the lines of the present *Jahresbericht*. On the other hand London, with the greatest systematic collection in the world and the addition of a perfect library, would naturally be the centre for the systematic part. The total result could be published in one volume, perhaps best at Leipzig, and the systematic part would be in English, while the morphological part could be in English, French, German, or whatever might be the language of the recorder, as it is now in the Naples *Jahresbericht*.

I think the advantages of such a scheme are obvious. By the combination the labour of recording would be enormously lessened, and the combined record need not be much more expensive than either one of the two now existing. At the same time authors could be encouraged to send in abstracts of their own works to one of the two editors. This would be an advantage in every way. In the first place authors would be sure of seeing a proper abstract of their papers published. I am sure it must be the experience of many who have published a memoir and afterwards read the abstract of it, that the abstract often gives a shockingly mutilated account of the results set forth in the original paper. By the omission of a qualifying phrase or sentence, an author's results are often made to appear in abstracts as absolute rubbish. I speak as one who has suffered.

On the other hand, the work of the recorder would be still further lightened by authors sending abstracts of their own works. It might be left to the editors' discretion to cut down an abstract if it was too long.

I feel confident that a scheme of combined records such as I have sketched out would cheapen the production of the Record to such an extent, that, amongst other things, it would be possible to pay a special recorder of the literature, that is to say, a person whose business it would be to go through all the periodicals and sort out the papers amongst the different recorders, as is actually done by the editor of the *Naples Jahresbericht*. In the present system of the English *Zoological Record* each recorder has to go through the whole of the periodicals, and if the group be a small one, *e.g.* sponges, the labour of searching for papers is out of proportion to the task of recording them. Moreover, it necessitates a longer or shorter residence in London near the British Museum Library, which may cost a recorder *more than he is paid* for his share of the Record. The duties of a recorder of the literature would be best undertaken by some one residing near the British Museum, as he could then get all the periodicals. During my residence in Naples last year I was unable to obtain all the periodicals in the enormous list of the *Zoological Record*, and thus I was obliged to leave out of my *Sponge and Echinoderm Record* for 1890 a great many papers which I am recording now for 1891.

A great need at the present moment is the intelligent organization of scientific research, and I venture to suggest the above scheme as an improvement upon the present organization as far as the recording of zoological literature is concerned. Perhaps in the far distant future a record of geology and botany might further be incorporated in the above scheme, to make an "International Record of the Progress of Biological Science." It is scarcely to be hoped, however, that we are within a measurable distance of such a convenience. Would it not be a reasonable thing that the Royal Society of London should initiate such a progress in the recording of scientific literature as that here advocated?

E. A. MINCHIN.

University Museum, Oxford, August 2.

Pilchards and Blue Sharks.

YOU may like to know that the pilchards in coming in on the Cornish coasts this season are followed by great quantities of blue sharks (*Squalus glaucus*) from four to nine feet in length.

Just now they are hanging about four or five miles from land, and evidently are disturbing the pilchards in their feeding very much, as they are not scattering and playing on the surface of the sea in the evening twilight as they usually do, but are keeping in closely-packed schools throughout the night; hence our fishermen are having a very uncertain time of it as the consequence, some boats having rather heavy catches, and others only a few hundred of fish. And all are complaining of the damage done to the nets by the sharp teeth of these monsters, as in attacking the pilchards in the fishermen's nets, there is no hesitancy on the part of the sharks, for the net is bitten through and carried off with the pilchards. Last Friday morning the fishing-boat *Wave* landed seven of these sharks, and the master said, had he desired it, he could have caught a dozen, or more.

MATTHIAS DUNN.

Mevagissey, Cornwall, August 16.

Aurora Borealis.

STANDING by the Hampstead Heath flagstaff last Friday evening (12th), a few minutes before ten, I witnessed a feeble but characteristic display of the Aurora Borealis. Looking to the north-west, and midway between Ursa Major and the horizon, was a speck of pale bluish-green luminousness. While wondering as to the cause, a flickering shaft of crimson-tinted light shot upward in the direction of the "Pointers." This was followed by other streamers and "glows," sometimes white, sometimes slightly coloured. Occasionally patches of hazy light would be formed, through which the stars could be seen, and once a number of horizontal bands or waves passed upward from the horizon in quick succession, travelling almost to the star G in Ursa Major before they faded away. At 10.20 p.m., when I left the spot, the streamers had apparently ceased, but the sky was still luminous. Throughout the display was very faint and the colours very weak—mere tints.

A. BUTCHER.

ON Friday evening, August 12th, between the hours of nine and ten p.m., there was visible here a magnificent display of the aurora borealis. The streamers were very bright at times, and those on each extreme were more or less reddish. I think it worth recording because of the unusual time of year for such a display. It was doubtless seen over a wide region, and the telegraph system may have had some experience of earth currents.

EDMUND MCCLURE.

Mundesley, Norfolk, August 13.

AN active aurora of great brilliancy was visible here on Friday night from nine till ten p.m. The whole realm of the sky from north-west to north-east and from horizon to zenith was filled with a vaporous and highly luminous mass with streamers and rays, the light sufficing for reading moderately large type. The streamers and rays were projected from the upper edge of an arch of dark-coloured vapours resting on the northern horizon. The sky space occupied by the points of the streamers covered the constellation Ursa Major on the west, Cassiopea on the east, and the intermediate region. Among the brilliant sheaf of white streamers an occasional dark-coloured ray shot upwards from the generating arch.

J. LLOYD BOZWARD.

Worcester, August 13.

Aurora Australis.

A FRIEND (Mr. Hamilton S. Dove) who has resided for several years in Tasmania having sent me a full account of an unusually splendid aurora recently observed by him, but which met with little notice even locally, I enclose a condensed description of it, thinking it worthy of record in your columns. In previous occurrences of Southern Aurora he had observed "only a greenish yellow light, and was very much surprised at the grand fiery-red cloud-like patches, which formed so striking a feature in this phenomenon."

WILLIAM WHITE.

The Ruskin Museum, Sheffield.

"On the night of Wednesday, May 18th, 1892, a grand display of aurora was witnessed by us in the Calder district, near the township of Wynyard, Table Cape, North-west Tasmania. The sun had set at about ten minutes to five, and the night was very clear and cold—no clouds were to be seen—with a keen frosty wind blowing from the south-west. Shortly after seven o'clock a bright light was visible above the southern horizon, somewhat similar to the light preceding sunrise. Then two broad zones of greenish light appeared, extending from the south-east to the south-west, in the form of a depressed arch, one zone being a short distance above the other, like the bands of a rainbow. At times parts of these bands faded, whilst other parts became brighter. Presently some patches of a dark-red colour, as of illuminated sunset clouds, began to appear above the zones of greenish light, spreading along, but with intervals between, the whole expanse of the zones—one specially large and deep red patch being conspicuous in the extreme south-west. These patches glowed and faded alternately in the same manner as the zones of greenish light.

"After continuing for the space of about half an hour the coloured lights gradually faded, leaving the strong whitish light which appeared at first. Towards nine o'clock, however, a further manifestation occurred, beginning with a brilliant red light in the south-east, and extending from the horizon to a considerable distance upward, resembling the glow from a huge fire. This also paled and brightened, till presently the two broad zones of greenish light again appeared, this time, however, confined chiefly to the south and south-east heavens, very little reaching south-west. After this reappearance of the zones some broad white stripes commenced to radiate from the horizon, crossing the zones more than half the way upwards to the zenith. The stripes began to appear near the red glow in the south-east, and several others occurred south-east by south, only two rather faint ones being to the west of south.

"Almost directly one of the white stripes appeared one of the red cloud-like patches came to the east of it, and gradually extended towards it, so that the sky above the zones of greenish-yellow light was eventually covered with red glowing patches and pale vertical stripes, which similarly paled and brightened.

"The later appearances, like the first, lasted for about half an hour and then disappeared, the moon rising soon afterwards.

"H. S. DOVE.
"G. W. EASTON."

Units Discussion at British Association.

REFERRING to the preliminary memorandum printed in your issue of August 4th, page 334, I wish to correct a slip in the statement about the fall between two surfaces joined by a "weber." I ought to have added, "if their area is one square centimetre." Enlargement of the area to a metre would diminish the pull to 40 tons. Also I may observe that at the meeting I did not press all the proposed resolutions, but withdrew Nos. 4, 5, 6, and 8.

OLIVER J. LODGE.

THE VARLEY TESTIMONIAL.

AN important Committee, containing among others, Lord Kelvin, Prof. Ayrton, Prof. G. Forbes, Dr. Gladstone, Prof. D. E. Hughes, Dr. J. Hopkinson, Prof. Kennedy, Prof. O. Lodge, Prof. J. Perry, Messrs. W. H. Preece, A. Siemens, A. Stroh, J. W. Swan, and Prof. S. Thompson, has been formed, to give effect to the feeling amongst some of the older members of the electrical profession that the life-long labours in electrical research of Mr. S. A. Varley should be recognised by some substantial testimonial befitting his reputation as a scientific investigator.

A brief sketch of Mr. Varley's career will serve to show what signal services he has rendered to the cause of electrical science and the honour his discoveries have conferred upon this country.

Mr. Samuel Alfred Varley was born in London in 1832, and was the third son of the late Mr. Cornelius Varley, an active man of science and an artist. In 1858, when the Atlantic cable was being constructed, he wrote a paper, read before the Institute of Civil Engineers, "On the Electrical Qualifications requisite in Long Submarine Cables," and was shortly afterwards elected an Associate Member of that Institution.

In the paper referred to above, Mr. Varley opposed the views of the electrical advisers of the company. Faraday, who had publicly supported their opinions, endorsed Mr. Varley's ideas immediately after receiving a copy of his paper. Mr. Varley followed this up by reading a second one before the Society of Arts in 1859, "On the Practical Bearing of the Theory of Electricity to Long Submarine Telegraphy." In this paper he suggested, among other things, the use of artificial lines, which have since proved of such value in connection with duplex working. In 1866 Mr. Varley discovered for himself the re-action or self-exciting principle, and at that early date constructed his first machine of the pure dynamo type, which is now in the Museum at South Kensington. His dynamo of 1866 was exhibited at the Inventions Exhibition of 1885, and for this he was awarded a gold medal.

The controversy which subsequently arose on this invention may be held to have been fitly summed up by the late Robert Sabine, C.E. (son-in-law of Sir Charles Wheatstone), in the following words :—"Professor Wheatstone says he was the first to complete and try the re-action machine. Mr. S. A. Varley was the first to put the machine officially on record in a provisional specification, dated December 24, 1866, which was, therefore, not published until July, 1867. Dr. Werner Siemens was the first to call public attention to the machine in a paper read before the Berlin Academy on the 17th January, 1867." (See *Engineering*, November, 1877.)

In 1866 he introduced needle-telegraph coils, in which soft-iron magnetically-induced needles were substituted for tempered steel needles. These induced and consequently undemagnetisable needles entirely superseded the old form introduced by Wheatstone and Cooke, and were largely adopted by the Postal Department. In the same year (1866) he designed a system of electric train inter-communication.

In the year 1875 Mr. Varley became assistant-manager of the works of the late British Telegraph Manufactory, Limited, and as the first Gramme machines constructed in England were manufactured by this firm, he had ample opportunities of studying the characteristics of both series wound machines and those having a seperate armature for excitation of the field magnets. There is scarcely a doubt that Mr. Varley's investigations at this period led to the invention of compound winding, for in 1876 he patented a series-shunt or compound-wound dynamo, and, in three legal suits, the claim that this specification first described a system of compound winding has been fully sustained. Mr. Varley has from time to time contributed papers read at the meetings of the British Association, among which may be mentioned one "On the Mode of Action of Lightning on Telegraph Circuits," wherein he described a lightning bridge designed by himself, a number of which are now doing duty, although fitted up more than twenty years ago.

But Mr. Varley's *magnum opus* is the important part which he took in the invention and perfecting of the dynamo, perhaps the most striking invention of the century, and upon this his fame as a patient, conscientious, and earnest scientific investigator of the Faraday school will permanently rest. His researches were undertaken in the true spirit of science, and no thought of self-emolument has ever caused him to deviate from the path which he has pursued throughout an eventful, although eminently simple and blameless life, a life in which self-denial and self-sacrifice have had no small share. Like many men of genius he was far ahead of the times, and has lived to see others reap the benefit of his great discoveries. His nervous and retiring disposition has for years kept him from the busy haunts of men, and to the younger generation of electricians he exists only in name, a name, however, that will live as long as the dynamo is employed in the service of man.

Subscriptions will be gladly received by the hon. treasurer, Mr. Stroh, 8 Haverstock Hill.

NOTES.

THE *Electrician* for August 5 contains an article on Lord Rayleigh, which is accompanied by a steel portrait.

AT a recent meeting of the Berlin Geographical Society, the chairman, Baron von Richthofen, announced that the society was about to publish, in commemoration of the 400th anniversary of the discovery of America, a work descriptive of the ancient manuscripts and maps in the Italian libraries relating to the history of this event. The German Emperor has promised a contribution of 15,000 marks towards the expense of the undertaking, and it is to be edited by Dr. Kretschmer. The accompanying atlas will contain thirty-five large maps, of which thirty-one are new, and will be published for the first time.

AT the lunch in the Library Hall, St. Andrews, on the 11th, to the party from the British Association, Prof. McIntosh announced that Mr. Charles Henry Gatty, of East Grinstead, had presented £1,000 for the purpose of establishing a Marine Laboratory at St. Andrews, which sum he further increased to £2,000 before the close of the day. The name of Mr. Gatty is sufficiently familiar to marine zoologists, were it only in connection with the accomplished lady (Mrs. Alfred Gatty), the favourite correspondent of Dr. George Johnston, of Berwick-on-Tweed. Mr. Gatty's munificent donation will enable St. Andrews to have a substantial and comfortable laboratory instead of the wooden building (formerly a fever hospital), which has hitherto been used for marine work since the period of the Trawling Commission under Lord Dalhousie. St. Andrews Marine Laboratory is the oldest permanent station in the country, and, as it has pre-eminent advantages in regard to varied and very rich marine fauna and flora, easy access to a fine University Library, and a University Museum—unique in certain departments, a new future is opened to it through Mr. Gatty's handsome gift. At the same meeting it was stated that the Fisheries prize of £20 given annually to the best student of Zoology (hitherto from an anonymous donor) was the gift of Mr. J. W. Woodall, of Scarborough. Both Mr. Gatty and Mr. Woodall were present.

DURING the past week the weather has been fine generally over the southern portion of the kingdom, but somewhat unsettled. The anticyclonic conditions which prevailed for a day or two in the middle of last week gave place on Friday, the 12th inst., to a south-westerly current, with showery weather, the rainfall being rather heavy in the north and west, while the low pressure over the north of Scotland caused rather strong gales and heavy seas on Saturday and Sunday. During the early part of the present week a depression advanced from the southward, occasioning unsettled weather and fog or mist in places, while exceptionally heavy rains occurred in parts of Ireland and Scotland, the amount measured at Parsonstown on Monday morning being 1·24 inches. During the week the maximum temperatures have nearly reached 80° in some parts of England and in the east of Scotland. For the week ending the 13th inst., temperature was below the mean in all districts, except the Channel Islands, where it just equalled it. The absolute minima, which were registered on the 11th, were exceedingly low for the time of year, and at many of the more inland stations frost was experienced on the grass.

THE fifth annual report of the National Association for the Promotion of Technical and Secondary Education has just been published, and satisfactory progress is shown. During the year a bi-monthly journal has been issued under the title of the *Record of Technical and Secondary Education*, in which detailed accounts of the work done by the County Councils have been given from time to time. The *Record* has to some extent relieved the pressure on the space of the report, which is shorter than its predecessors.

THE *Ceylon Observer* for July 21 has an editorial on "Marine Biological Stations," and while sympathizing with the decision of the meeting which was called together a short time ago to take steps to establish a station in the island of Jamaica, ventures the hope that Ceylon, too, may have its marine biological station, and points out how particularly well situated that island is for such an undertaking.

WE refer elsewhere to Prof. Forel's report on the present extension of the Alpine glaciers, to which, whatever the *modus operandi*, the disaster of St. Gervais was due. A letter in Tuesday's *Times* refers to Mr. Douglas Freshfield's warning that there may still be an excess of water ready to discharge itself in the neighbourhood of the Aiguille du Gouté, and states that the view has received a remarkable confirmation. While a party was breakfasting at the Pierre Pointue, which overhangs the stream that drains the eastern wing of the Glacier des Boisons, a tremendous noise suddenly brought them all—visitors and *employés* of the chalet—out upon the platform to see the violent flood of opaque brown fluid which tore down the bed of the stream which had been flowing so quietly before. No great damage seems to have been done, but certainly the occurrence will strengthen the view that careful scientific studies should be made so that complete warning may in all cases be given.

AN address on "Geological Chronology," which Prof. Young delivered to the Physical Society of Glasgow University in February last, has been published in pamphlet form by Messrs. Carter and Pratt, Glasgow.

A PRELIMINARY draft prospectus of a new physical atlas, which Messrs. J. Bartholomew and Co., Edinburgh, have in preparation, has reached us. The work will be based upon Berghaus's "Physikalischer Atlas," published by Justus Perthes, of Gotha, 1889–92, but will, we understand, be much larger and more extensive, and contain a great deal of entirely new and original matter. According to the present intentions of the compilers, the work will be issued in five separate sections as follows: (1) Geology; (2) Orography and Hydrography; (3) Meteorology and Magnetism; (4) Botany and Zoology; (5) Ethnography and Geographical Demography, and when complete may be obtained either in one complete volume, or in five smaller volumes. The joint authors will be Mr. J. G. Bartholomew and Dr. H. R. Mill, and the various sections will be revised and edited by, amongst others, Prof. Bayley Balfour, Dr. A. Buchan, Sir Archibald Geikie, Prof. James Geikie, and Dr. John Murray.

THE *Times* of Tuesday states that Lieutenant Bower has discovered in Chinese Turkestan the remains of a subterranean city, in one of the excavations near which he found a curious birch-bark manuscript, which he took with him back to India for the investigation of scholars. The manuscript is described as having been dug out of the foot of one of the curious old erections just outside a subterranean city near Kuchar. These erections are said to be about 50 feet to 60 feet high, in shape like a huge cottage loaf, built solid with sun-dried bricks, with layers of beams now crumbling away. Dr. Hoernle, who undertook the examination of the manuscript, thinks that these erections are Buddhist stupas, which often contain a chamber enclosing relics and other objects. These chambers are generally near the level of the ground, and are often excavated by persons in search of hidden treasure. There is no reason why a birch-bark manuscript, thus preserved from the chances of injury, should not last for an almost indefinite period, especially if the chamber is air-tight. Dr. Hoernle has now communicated to the Asiatic Society of Bengal the result of his examination of the manuscript. It is written in Sanscrit of a very archaic type, not in the Sarada character of Cashmere, as was at first surmised, but in the Gupta character, which is a much earlier form. Separate portions of it were written by different scribes and at different dates, and the latest portion must, he thinks, be ascribed to a period not later than the second half of the fifth century—say 475 A.D.—while the earlier portion must be referred to a date half a century earlier. The manuscript is therefore the oldest Indian manuscript, and one of the oldest manuscripts existing in the world. The manuscript consists of fifty-five leaves, all of which have now been transcribed and the greater part translated by Dr. Hoernle, and both will be published in instalments by the Asiatic Society of Bengal.

THE *Times* India correspondent gives us some important intelligence regarding Mr. Conway's exploring party in the Hindu-Kush. The party has arrived at Askoleya after making the first definitely recorded passage of the Hispar Pass—the longest glacier pass in the world. The party left Nagar on June 27, spent ten days exploring the vast system of glaciers not marked on any map which covers the north slopes of the main Hindu-Kush range in that neighbourhood. Mr. Conway ascended a difficult rock peak of 17,000 feet, and attempted the ascent of the Great Nagar Mountain, but he was driven back by a hundred yards of ice fall, that proved to be absolutely impassable. On July 11, after a day's halt at Hispar, Mr. Conway started up the great glacier and reached the foot of Nushik in three short marches. The next day being cloudy he did not go to the top of Nushik, as he had intended, but he sent a party under Mr. Rondebush to cross that pass. They took all the spare baggage and conveyed it by the Braldo Valley to Askoleya. Meanwhile Mr. Conway and Mr. M'Cormick with an Alpine guide, Zurbuggen, continued three more marches up the great Hispar glacier to the pass, which they actually crossed on July 18. The view from the pass is said to be superb, over a vast lake of snow some 300 miles in area, quite flat, surrounded by a ring of giant peaks and with a row of peaks rising like islands in the midst of it. They camped just below the pass on the east side and were overtaken by a severe snowstorm. They descended two marches down the Biafo glacier to the level of grass, whence they sent Zurbuggen to Askoleya, which he reached in one long day's march. Mr. Conway spent six days on the way, chiefly occupied in surveying, which the continued bad weather rendered difficult. The whole party re-united at Askoleya on July 26. The length of the pass from the foot of the Hispar Pass to the foot of the Biafo glacier is about ninety miles. The mercury on the pass stood at 15·85 in. No one suffered perceptibly from the rarefaction of the air.

The latest news from Etna is that Monte Gemmellaro has broken out afresh, and the great lava current that has been flowing from it has now been divided into two arms, both of which are rapidly advancing in the direction of Serra Pizzuto and Pedova, completely covering *en route* the lavas of 1886. The deluges of molten rock that have been emitted during the last month have destroyed one of the finest and most fertile districts in Sicily.

Prof. Forel has recently prepared a table (*Arch. de Sci.* July 15) showing the behaviour of the small lake at the Great St. Bernard in regard to cold since 1817. This lake is at a height of about 8000 feet, is about 24 acres in surface, and of small depth. It appears the mean duration of the frozen state is about 268 days; for nearly two-thirds of the year the lake is imprisoned "under a carapace of ice and snow." This justifies only too well the remark of the monk, "Nine months of winter and three months of bad weather." Between the earliest date of freezing (September 30) and the latest (November 6) are 36 days, the mean date being October 20. The earliest date of thawing is June 12, and the latest September 15; difference 95 days (the mean date being July 13). By grouping the dates in a series of decades (approximately) Prof. Forel finds maxima of duration of the frozen state in 1840–49 and in 1880–91, and a minimum in 1860–69. This corresponds fairly, he points out, with the phases of Brückner's cycle, according to which a maximum of cold occurred about 1850, a maximum of heat about 1860, and a maximum of cold about 1880.

By the election of the present holder—Mr. A. A. Kanthack—to the Medical Tutorship of the Liverpool University College Medical School, the John Lucas Walker Studentship in Pathology at Cambridge will shortly become vacant. The studentship is of the annual value of £250, and is tenable for three years. Candidates should send in their applications and testimonials by October 25, to Prof. Roy, F.R.S., New Museum, Cambridge.

We learn from the *British Medical Journal* that the Library of the British Medical Association has been presented with a valuable gift of a series of important works, bearing chiefly on hygiene and public medicine, from the library of the late Dr. Alfred Carpenter. The books number upwards of 250 volumes, and are the gift of Mrs. Carpenter.

An interesting account of a visit by Mr. E. Satow to the ruins of Sukkhothai and Sawankhalôk, Siam, appears in the Journal of the Society of Arts, for August 12.

A new edition—the sixth—of "The Electric Light popularly explained," by A. Bromley Holmes, has just been brought out by Messrs. Bemrose and Sons, Limited.

"Papers and Proceedings of the Royal Society of Tasmania for 1891" has just reached us, and we learn from the report that during the year six meetings were held and thirteen papers were read; the income amounted to £393, and the expenditure to £235 1*s.* 1*d.*

A Catalogue of Standard English and Foreign Books on Chemistry and the Allied Sciences has just been issued by Mr. W. F. Clay, Edinburgh.

The Annual Report of the Superintendent, Mr. J. H. Hart, on the Royal Botanic Gardens, Trinidad, for 1891, has lately been published, and much good work seems to have been accomplished during the year.

We have received from the Australian Museum, Sydney, Parts I. (Cephalopoda) and II. (Pteropoda) of the Catalogue of the Marine Shells of Australia and Tasmania, which Mr. John Brazier is compiling.

A pamphlet on "The Dairy and its Equipment, with Practical Management of Milk and Cream," which has been written by Dr. H. J. Webb (the Principal of the Aspatria Agricultural College) in conjunction with Mrs. Edward Moul, and recently issued, is full of information likely to be of use to those engaged in dairy-work.

In the *American Naturalist* for August, Dr. S. Lockwood gives a geological reason "Why the Mocking Birds Left New Jersey," and the report of Prof. Osborn's lectures on "Heredity and the Germ-Cells" is continued.

Naturae Novitates for July has reached us from the publishers, R. Friedländer & Sohn, Berlin.

Three new volumes have been added to the excellent series entitled "Encyclopédie Scientifique des Aide-Mémoire" (Gauthier-Villars)—"Notions de Chimie Agricole," by J. Schlœsing, Fils; "Les Divers Types de Moteurs à Vapeur," by E. Sauvage; "La Bière," by L. Lindet.

The additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. H. D. Bowditch; a Puma (*Felis concolor*), a Tayra (*Galictis barbara*) from Brazil, presented by Mr. J. E. Wolfe; three Martineta Tinamous (*Colodromus elegans*) from Bahia Blanca, Argentina, presented by Mr. F. W. Horn; a Slender-billed Cockatoo (*Licmetis tenuirostris*) from Australia, presented by Dr. J. G. Victor Sapp; a Californian Sea Lion (*Otaria stelleri*) from the North Pacific, an Indian Chevrotain (*Tragulus meminna*, ♀) from India, deposited; an Indian Oriole (*Oriolus kundoo*), two —— Himalayan Tree Pies (*Dendrocitta himalayensis*) from India, five Black-necked Tanagers (*Euphonia nigricollis*), six Thick-billed Tanagers (*Euphonia laniirostris*), a Violet Tanager (*Euphonia violacea*), a Greenish Tanager (*Euphonia chlorotica*), a Lead-coloured Tanager (*Hypophœa chalybea*) from Brazil, purchased; a Magellanic Goose (*Bernicla magellanica*) bred in Holland, six Himalayan Tree Pies (*Dendrocitta himalayensis*) from India, received in exchange.

OUR ASTRONOMICAL COLUMN.

The Perseids.—Mr. Denning, in the August number of *The Observatory*, remarks, with reference to the radiant point of the Perseids, that "the agreement of observation and theory is not perfect, especially as regards the shower at its earlier stages and at its termination, when the displacement appears to be somewhat greater than theory requires." From observations made on August 16, 1877, the radiant he deduced was $60^\circ + 59^\circ$, the theoretical position, according to Dr. Kleiber, being $54^\circ + 59^\circ$. In 1886, on the same date, from the path of a very bright Perseid, Mr. Denning obtained a radiant point of $53^\circ + 59^\circ$, a value closely approaching the theoretical one. As Mr. Denning has reason to believe that the Perseids will continue to fall until the 22nd of this month, and as the suspected radiant for this date is about $77^\circ + 56\frac{1}{2}^\circ$, our readers will have an opportunity of either verifying this position or obtaining one more accurate.

The observations of the August meteors seem to have been sadly interfered with by the weather. So far we have received no communication respecting them.

"Himmel und Erde."—The August number of *Himmel und Erde* contains much that will be read with interest. Herr J. Plassmann contributes an article, which will be continued in the next issue, on variable and new stars, in which, after referring to the peculiar features of the late nova, he discusses the light curves of many well-known variables. A supplement to the note on the great February spot includes an illustration showing the movement in the line of sight of the F line caused by the presence of a protuberance in the region of the spot. "The Length of our Earth-days," "A Lost Comet," and "Paris Scientific Undertakings" are titles of other communications, the last of which is a brief general survey of recent additions to our knowledge about the construction and movement of the visible universe.

Astronomy at the Columbian Exposition.—Arrangements are about to be made for organizing a series of congresses or conventions to be held next year during the progress of the World's Exposition. The preliminary address of the General Committee on Mathematics and Astronomy points out that such a congress should take advantage of the presence of the leading scholars of the world for the mutual interchange of ideas by presenting and considering investigations in special lines of research.

The sections dealing with Astronomy and Astro-Physics are eight in number and are as follows:—

Astronomy.

a. History of Astronomy.
b. Astronomical Instruments.
c. Methods of Observation.
d. Physical Astronomy.
e. Observatory Buildings.

Astro-Physics.

a. Spectrum Analysis.
b. Astronomical Photography.
c. Stellar Photometry.

The address further states that advice and suggestions with regard to the general conduct of the convention are earnestly invited, while special stress is laid on the scientific questions for future discussion. The Chairmen of the Special Committees of the several subjects under the charge of the General Committee are as follows:—

Pure Mathematics.—Prof. E. H. Moore, Chicago University.
Astronomy.—Prof. G. W. Hough, Dearborn Observatory, North-western University, Evanston.
Astro-Physics.—Prof. George E. Hale, Kenwood Astro-Physical Observatory, Chicago.

Among the names in the partial lists of the Advisory Councils on these two subjects we notice those of Prof. A. Cayley and Prof. J. J. Sylvester for mathematics, and S. Copeland (Astronomer Royal for Scotland), Prof. R. S. Ball, Prof. Gill, Mr. Norman Lockyer, the Earl of Rosse, Prof. Liveing, Prof. Dewar, and Dr. Huggins.

Lunar Eclipse, May 11, 1892.—With reference to the lunar eclipse that occurred last May, *Astronomische Nachrichten* No. 3106 contains a series of accounts, which include the times of immersion and emersion of the objects on the moon's surface, gathered from the following observatories:—Bonn, Heidelberg, Breslau, Christiania, Prag, Kiel, and Kalocsa.

Numeration of Asteroids.—The *Astronomical Journal* No. 271 contains the announcement that an arrangement had been agreed upon by which the numeration of asteroids will in future be put on a sound basis. For the present Prof. Krueger will assign to these bodies the notation 1892 A, B, C...in the order in which their announcement is sent to the Telegraphische Central-Stelle, Prof. Tietzen, Director of the Rechen Institute in Berlin, in the meantime undertaking their definite numeration. This arrangement will be found to avoid all such confusion as has been experienced with regard to those asteroids about which sufficient information is not available for their orbital determinations. Although they will not now receive their numbers, they can easily be recognized by their lettering in the annual series.

THE BRITISH ASSOCIATION.

SECTION C.

Geology.

Opening Address by Prof. C. Lapworth, LL.D., F.R.S., F.G.S., President of the Section.

It has, I believe, been the rule for the man who has been honoured by election to the chair of President of the Geological Section of the British Association to address its members upon the recent advances made in that branch of geology in which he has himself been most immediately interested. It is not my intention upon the present occasion to depart from this time-honoured custom; for it has both the merit of simplicity and the advantage of utility to recommend it. In this way each branch of our science, as it becomes in turn represented, not only submits to the workers in other departments a report of its own progress, but presents by implication a broad sketch of the entire geological landscape, seen through the coloured glasses, it may be, of divisional prejudice, but at any rate instructive and corrective to the workers in other departments, as being taken from what is to them a novel and an unfamiliar point of view.

Now every tyro in geology is well aware of the fact that the very backbone of geological science is constituted by what is known as stratigraphical geology, or the study of the geological formations. These formations, stratified and unstratified, build up all that part of the visible earth-crust which is accessible to the investigator. Their outcropping edges constitute the visible exterior of our globe, the surface of which forms the physical geography of the present day, and their internal characters and inter-relationships afford us our only clues to the physical geographies of bygone ages. Within them lies enshrined all that we may ever hope to discover of the history and the development of the habitable world of the past.

These formations are to the stratigraphical geologist what species are to the biologist, or what the heavenly bodies are to the astronomer. It was the discovery of these formations which first elevated geology to the rank of a science. In the working out of their characters, their relationships, their development, and their origin, geology finds its means, its aims, and its justification. Whatever fresh material our science may yield to man's full conception of nature, organic and inorganic, must of necessity be grouped around these special and peculiar objects of its contemplation.

When the great Werner first taught that our earth-crust was made up of superimposed rock-sheets or formations arranged in determinable order, the value of his conclusions from an economic point of view soon led to their enthusiastic and careful study; and his crude theory of their successive precipitation from a universal chaotic ocean disarmed the suspicions of the many until the facts themselves had gained such a wide acceptance that denial was no longer possible. But when the greater Hutton asserted that each of these rock formations was in reality nothing more nor less than the recemented ruins of an earlier world, the prejudices of mankind at large were loosed at a single stroke. Like Galileo's assertion of the movement of the globe, this demanded such an apparently undignified and improbable mode of creation that there is no wonder that, even down to the present day, there still exist some to whom this is a hard saying, to be taken, if taken at all, in homœopathic doses and with undisguised reluctance.

Hutton, as regards his philosophy, was, as we know, far in advance of his time. With all the boldness of conviction he unflinchingly followed out these ideas to their legitimate results. He claimed that as the stratified formations were composed of similar materials—sands, clays, limestones, and muds—to those now being laid down in the seas around our present coasts, they must, like them, have been the products of ordinary natural agencies—of rain, rivers, and sea waters, internal heat and external cold—acting precisely as they act now. And further as these formations lie one below the other, in apparently endless downward succession, and all are formed more or less of these fragmentary materials, so the present order of natural phenomena must have existed for untold ages. Indeed, to the commencement of this order he frankly admits, "I see no trace of a beginning or sign of an end."

The history of the slow acceptance of Hutton's doctrines, even among geologists, is, of course, perfectly familiar to us all. William Smith reduced the disputed formations to order, and showed that not only was each composed of the ruins of a vanished land, but that each contained in its fossils the proof that it was deposited in a vanished sea inhabited by special life creation. Cuvier followed, and placed it beyond question that the fossilized relics of these departed beings were such as made it absolutely unquestionable that these creatures might well have inhabited the earth at the present day. Lyell completed the cycle by demonstrating stage by stage the efficiency of present natural agencies to do all the work required for the degradation and rebuilding of the formations. Since his day the students of stratigraphical geology have universally acknowledged that in the study of present geographical causes lies the key to the geological formations and the inorganic world of the past.

In this way the road was paved for Darwin and the doctrine of descent. The aid which had been so ungrudgingly afforded by biology to geology was repaid by one of the noblest presents ever made by one science to another. For the purposes of geology, the science of biology had practically completed a double demonstration: first, that the extinct life discernible in the geological formations was linked inseparably with the organic life of the present; and, second, that every fossil recognized by the geologist was the relic of a creature that might well have existed upon the surface of the earth at the present time. Geology repaid its obligation to biology by the still greater twofold demonstration: first, that in the economy of nature the most insignificant causes are competent to the grandest effects, if only a sufficiency of time be granted them; and, second, that in the geological formations we have the evidences of the actual existence of those mighty æons in which such work might be done.

The doctrine of organic evolution would always have remained a metaphysical dream had geology not given the time in which the evolution could be accomplished. The ability of present causes to bring about slow and cumulative changes in the species is, to all intents and purposes, a biological application of Hutton's ideas with respect to the original geological formations. Darwin was a biological evolutionist, because he was first an uniformitarian geologist. Biology is pre-eminent to-day among the natural sciences, because its younger sister, Geology, gave it the means.

But the inevitable consequence of the work of Darwin and his colleagues was that the centre of gravity, so to speak, of popular regard and public controversy was suddenly shifted from stratigraphical geology to biology. Since that day stratigraphical geology, to its great comfort and advantage, has gone quietly on its way unchallenged, and all its more recent results have, at least by the majority of the wonder-loving public, been practically ignored.

Indeed, to the outside observer it would seem as if stratigraphical geology for the last thirty years had been practically at a standstill. The startling discoveries and speculations of the brilliant stratigraphists of the end of the last century and first half of the present forced the geology of their day into the very front rank of the natural sciences, and made it perhaps the most conspicuous of them all in the eyes of the world at large. Since that time, however, their successors have been mainly occupied in completing the work of the great pioneers. The stratigraphical geologists themselves have been almost wholly occupied in laying down upon our maps the superficial outlines of the great formations, and working out their inter-relationships and subdivisions. At the present day the young stratigraphical student soon learns that all the limits of our great formations have been laid down with accuracy and clearness, and finds but little to add to the accepted nomenclature of the time.

Our palæontologists also have equally busied themselves in working out the rich store of the organic remains of the geological formations, and the youthful investigator soon discovers that almost every fossil he is able to detect in the field has already been named, figured, and described, and its place in the geological record more or less accurately fixed.

In France, in Germany, in Norway, Sweden, and elsewhere, in Canada and in the United States, work as thorough and as satisfactory has been accomplished, and the local development of the great stratified formations and their fossils laid down with detail and clearness.

Many an unfledged, but aspiring geologist, alive to these facts, and contrasting the well-mapped ground of the present time with the virgin lands of the days of the great pioneers, finds it hard to stifle a feeling of keen regret that there are nowadays no new geological worlds to conquer, no new systems to discover and name, and no strange and unexpected faunas to unearth and bring forth to the astonished light of day. The youth of stratigraphical geology, with all its wonder and freshness, seems to have departed, and all that remains is to accept, to commemorate, and to round off the glorious victories of the dead heroes of our science.

But to the patient stratigraphical veteran, who has kept his eyes open to discoveries new and old, this lull in the war of geological controversy presents itself rather as a grateful breathing time; the more grateful as he sees looming rapidly up in front the vague outlines of those oncoming problems which it will be the duty and the joy of the rising race of young geologists to grapple with and to conquer, as their fathers met and vanquished the problems of the past. He knows perfectly well that Geology is yet in her merest youth, and that to justify even her very existence there can be no rest until the whole earth-crust and all its phenomena, past, present, and to come, have been subjected to the domain of human thought and comprehension. There can be no more finality in Geology than in any other science; the discovery of to-day is merely the stepping-stone to the discovery of to-morrow; the living theory of to-morrow is nourished by the relics of its parent theory of to-day.

Now if we ask what are these formations which constitute the objects of study of the stratigraphical geologist, I am afraid that, as in the case of the species of the biologist, no two authorities would agree in framing precisely the same definition. The original use of the term *formation* was of necessity lithological, and even now the name is most naturally applied to any great sheet of rock which forms a component member of the earth-crust; whether the term be used specifically for a thin homogeneous sheet of rock like the Stonesfield slate, ranging over a few square miles; or generically, for a compound sheet of rock, like the Old Red Sandstone, many thousands of feet in thickness, but whose collective lithological characteristics give it an individuality recognizable over the breadth of an entire continent.

When Werner originally discovered that the "formations" of Saxony followed each other in a certain recognizable order, a second characteristic of a formation became superposed upon the original lithological conception—namely, that of determinate "relative position." And when William Smith proved that each of the formations of the English Midlands was distinguished by an assemblage of organic remains peculiar to itself, there became added yet a third criterion—that of the possession of "characteristic fossils."

But these later superposed conceptions of time-succession and life-type are far better expressed by dividing the geological formations into zoological *zones*, on the one hand, and grouping them together, on the other hand, into chronological *systems*. For in the experience of every geologist he finds his mind instinctively harking back to the bare lithological application of the word "formation," and I do not see that any real advantage is gained by departing from the primitive use of the term.

A *zone*, which may be regarded as the *unit* of *palæontological succession*, is marked by the presence of a special fossil, and may include one or many subordinate formations. A *system*, which is, broadly speaking, the *unit of geological succession*, includes many "zones," and often, but not always, many "formations." A *formation*, which is the *unit of geological stratigraphy*, is a rock sheet composed of many strata possessing common lithological characters. The formation may be simple, like the Chalk, or compound, like the New Red Sandstone; but, simple or compound, local or regional, it must be always recognizable, geographically and geologically, as a lithological individual.

As regards the natural grouping of these lithological individuals as such, fair progress has been made of late years, and our information is growing apace. We know that there are at any rate three main groups: 1st. The stratified formations due to the action of moving water above the earth-crust; 2nd. The igneous formations which are derived from below the earth-crust; 3rd. The metamorphic formations which have undergone change within the earth-crust itself. We know also that of these three the only group which has hitherto proved itself available for the purpose of reading the past history of the globe is that of the stratified formations.

Studying these stratified formations therefore in greater detail, we find that they fall naturally in their turn into two sets—viz., a mechanical set of pebble beds, sandstones and clays formed of rock fragments washed off the land into the waters, and an organic set of limestones, chalk, &c., formed of the shells and exuviæ of marine organisms.

But when we attempt a further division of these two sets our classification soon begins to lose its definiteness. We infer that some formations, such as the Old Red and the Triassic, were the comparatively rapid deposits of lakes and inland seas; that others, like the Coal Measures, London Clay, &c., were the less rapid deposits of lagoons, river valleys, deltas, and the like; that others, like our finely laminated shales and clays of the Silurian and Jurassic, were the slower deposits of the broader seas; and finally, that others, like our Chalk and Greensand, were possibly the extremely slow deposits of the more oceanic deeps.

Nevertheless, after looking at the formations collectively, there remains no doubt whatever in the mind of the geologist that their mechanical members are the results of the aqueous degradation of vanished lands, and that their organic members are the accumulated relics of the stony secretions of what once were living beings. Neither is there any possibility of escape from the conclusion that they have all been deposited by water in the superficial hollows of the sea-bottoms and ocean floors of the earth-crust of their time.

In the life of every individual stratified formation of the mechanical type we can always distinguish three stages: first, the stage of erosion and transportation, in which the rock fragments were worn off the rocks of the higher ground and washed down by rain and rivers to the sea; second, a stage of deposition and consolidation below the surface of the quiet waters; and third, a final stage in which the completed rock-formation was bent and upheaved, in part at least, into solid land. In the formations of the organic type three corresponding stages are equally discernible: first, the period of mineral secretion by organized beings; second, the period of deposition and consolidation; and third, the final period of local elevation in mass. But one and all, mechanical and organic alike, they bear in their composition, in their arrangement, and in their fossils, abundant and irresistible evidences that they *were* the products, and that now they *are* the memorials of the physical geography of their time.

Guided by the principles of Hutton and Lyell, geologists have worked out with great care and completeness the effects of those agencies which rule in the first of these three life-stages in the history of a mechanical formation. No present geological processes are better known to the young geologist than those of denudation, erosion, and transportation, so familiar to us in the eloquent works of our President. They form together the subject-matter of that most wonderful fascinating chapter in geology, which from its modest opening among the quiet Norfolk sandhills sweeps upwards and onwards without a break to its magnificent close on the brink of the gorge of the Colorado. But our knowledge of the detailed processes of deposition and consolidation which rule in the second stage is still exceedingly imperfect, although a flood of light has been thrown upon the subject by the brilliant results of the *Challenger* expedition. And we are compelled to admit that our knowledge of the operations of those agencies which rule in the processes of upheaval and depression is as yet almost nil; and what little we have already learnt of the effects of those agencies is the prey of hosts of conflicting theories that merely serve to annoy and bewilder the working student of the science.

But not one of the formative triad of detrition, deposition, and elevation can exist without the others. No detrition is possible without the previous upheaval of the rock-sheet, from which material can be removed; no deposition is possible without the previous depression of the rock-sheet, which forms the basin in which the fragmentary material can be laid down.

Our knowledge, therefore, of the origin and meaning of any geological formation whatever, can at most be only fragmentary until this third chapter in the life-history of the geological formation has been attacked in earnest.

Now all the rich store of knowledge that we possess respecting the first stage in the life of a geological formation has been derived from a comparison of certain phenomena which the stratigraphical geologist finds in the rock formations of the past, with correspondent phenomena which the physical geographer discovers on the surface of the earth of the present. And all that we know of the second stage again has been obtained in precisely the same way. Surely analogy and common sense both teach us that all which is likely to be of permanent value to us as regards the final stage of elevation and depression must first be sought for in the same direction.

Within the last twenty years or so many interesting and vital discoveries have been made in the stratigraphy of the rock formations, which bear largely upon this obscure chapter of elevation and depression. And I propose on this occasion that we try to summarize a few of these new facts, and then, reading them in conjunction with what we actually know of the physical geography of the present day, try to ascertain how such mutual agreement as we can discover may serve to aid the stratigraphical geologist in his interpretation of the true meaning of the geological formations themselves. We may not hope for many years to come to read the whole of this geological chapter, but we may perhaps modestly essay an interpretation of one or two of the opening paragraphs.

In the physical geography of the present day we find the exterior of our terraqueous globe divided between the two elements land and water. We know that the solid geological formations exist everywhere beneath the visible surface of the lands, but of their existence under the present ocean floor we have as yet no absolute certainty. We know both the form of the surface and the composition of the outer layers of the continental parts of the lithosphere; we only know as yet even in outline the form of the surface of its oceanic portions. The surface of each of our great continental masses of land resembles that of a long and broad arch-like form, of which we see the simplest type in the New World. The surface of the North American arch is sagged downwards in the middle into a central depression which lies between two long marginal plateaux, and these plateaux are finally crowned by the wrinkled crests which form its modern mountain systems. The surface of each of our ocean floors exactly resembles that of a continent turned upside down. Taking the Atlantic as our simplest type, we may say that the surface of an ocean basin resembles that of a mighty trough or syncline, buckled up more or less centrally into a medial ridge, which is bounded by two long and deep marginal hollows, in the cores of which still deeper grooves sink to the profoundest depths. This complementary relationship descends even to the minor features of the two. Where the great continental sag sinks below the ocean level, we have our gulfs and our Mediterraneans, seen in our type continent as the Mexican Gulf and Hudson Bay. Where the central oceanic buckle attains the water-line, we have our oceanic islands, seen in our type ocean as St. Helena and the Azores. Although these apparent crust-waves are neither equal in size nor symmetrical in form, this complementary relationship between them is always discernible. The broad Pacific depression seems to answer to the broad elevation of the Old World—the narrow trough of the Atlantic to the narrow continent of America.

Every primary wave of the earth's surface is broken up into minor waves, in each of which the ridge and its complementary trough are always recognizable. The compound ridge of the Alps answers to the compound Mediterranean trough; the continous western mountain chain of the Americas to the continuous hollow of the Eastern Pacific which bounds them; the sweep of the crest of the Himalaya to the curve of the Indo-Gangetic depression. Even where the surface waves of the lithosphere lie more or less buried beneath the waters of the ocean and the seas, the same rule always obtains. The island chains of the Antilles answer to the several Caribbean abysses, those of the Ægean Archipelago answer to the Levantine deeps.

Draw a section of the surface of the lithosphere along a great circle in any direction, the rule remains always the same: crest and trough, height and hollow, succeed each other in endless sequence, of every gradation of size, of every degree of complexity. Sometimes the ridges are continental, like those of the Americas; sometimes orographic, like those of the Himalaya; sometimes they are local, like those of the English Weald. But so long as we do not descend to minor details we find that every line drawn across the earth's surface at the present day rises and falls like the imaginary line drawn across the surface of the waves of the ocean. No rise of that line occurs without its complementary depression; the two always go together, and must of necessity be considered together. Each pair constitutes one of those *geographical units of form* of which every continuous direct line carried over the surface of the lithosphere of our globe is made up. This unit is always made up of an arch-like rise and a trough-like depression, which shade into each other along a middle line of contrary curvature. It resembles the letter S or Hogarth's line of beauty, and is clearly similar in form to the typical wave of the physicist. Here, then, we reach a very simple and natural conclusion, viz. the surface of the earth-crust of the present day resembles that of a series of crust-waves of different lengths and different amplitudes, more or less irregular and complex, it is true, but everywhere alternately rising and falling in symmetrical halves like the waves of the sea.

Now this rolling wave-like earth-surface is formed of the outcropping edges of the rock formations which are the special objects of study of the stratigraphical geologist. If, therefore, the physiognomy of the face of our globe is any real index of the character of the personality of the earth-crust beneath it, these collective geographical features should be precisely those which answer to the collective structural characters of the geological formations.

In the earlier days of geology one of the first points recognized by our stratigraphists was the fact that the formations were successive lithological sheets, whose truncated outcropping edges formed the present surface of the land, and that these sheets lay inclined at an angle one over the other, or as William Smith quaintly expressed it, like a tilted "pile of slices of bread and butter." But as discovery progressed the explanation of this arrangement soon became evident. The formations revealed themselves as a series of what had originally been deposited as horizontal sheets, lying in regular order one over the other, but which had been subsequently bent up into alternating arches and troughs (*i.e.* the anticlines and synclines of the geologist). Their visible parts, which now constitute the surface of our habitable lands, were simply those parts of the formations which are cut by the irregular plane of the present earth's surface. All those parts of the great arches and troughs formerly occurring above that plane have been removed by denudation; all those parts below that plane lie buried still, out of sight within the solid earth-crust.

Although in every geological section of sufficient extent it was seen that the anticline or arch never occurred without the syncline or trough—in other words, that there was never a rise without a corresponding fall of the stratum, yet it is only of late years that the stratigraphical geologist has come clearly to recognise the fact that the anticline and syncline must be considered together, and must be united as a single crust-wave. For the arch is never present without its complementary trough, and the two together constitute the *tectonic*, *structural*, or *orographic unit*, namely, *The Fold*, the study of which, so brilliantly inaugurated by Heim in his "Mechanismus der Gebirgsbildung," is destined, I believe, in time, to give us the clue to the laws which rule in the local elevation and depression of the earth-crust, and furnish us with the means of discovery of the occult causes which lie at the source of those superficial irregularities which give to the face of our globe its variety, its beauty, and its habitability.

We have said already that this wave or fold of the geologist resembles that of the wave of the physicist. Now we may regard such a wave as formed of two parts, the arch-like part above and the trough-like part below. The length of the wave is naturally the length of the axial line joining the outer extremities of the arch and trough, and passing through the centre, node, or point of origin of the wave itself, which bisects the line of contrary curvature. The amplitude of the wave is the height of the arch added to the depth of the trough. The arch part of such a wave, if perfectly symmetrical, may clearly be regarded as belonging either to a wave travelling to the right, in which case the complementary trough is the one in that direction, or it may be regarded as belonging to a wave travelling to the left, in which case its trough must be the one in that direction. But as in the case of the shore wave, the advancing slope of the wave is always the steeper, and the real centre of the wave must lie half-way down this steeper slope; so there is no difficulty in recognizing the centre of a geological fold and fixing the real direction of movement.

The fold of the geologist differs from the ordinary wave of the physicist, essentially in the fact that even in its most elementary conception, as that of a plate bent by a pressure applied from opposite sides, it necessarily includes the element of thickness. And this being the case, the rock sheet which is being folded and curved has different layers of its thickness affected differently. In the arch of the fold the upper layers of the rock sheet are extended, while its lower layers are compressed. On the contrary in the trough of the fold the upper layers are compressed and the lower layers are extended. But in arch and trough alike there exists a central layer, which, beyond taking up the common wave-like form, remains practically unaffected.

But the geological fold has in addition to length and thickness, the further element of breadth, and this fact greatly complicates the phenomena.

Many of the movements which take place in a rock sheet which is being folded, or in other words those produced by the bending of a compound sheet composed of many leaves, can be fairly well studied in a very simple experiment. Take an ordinary large note-book, say an inch in thickness, with flexible covers. Rule carefully a series of parallel lines across the edges of the leaves at the top of the book, about $\frac{1}{8}$ of an inch apart, and exactly at right angles to the plane of the cover. Then, holding the front edges loosely, press the book slowly from back and front into an S-like form until it can be pressed no further. As the wave grows, it will be noticed that the cross lines which have been drawn on the upper edge of the book remain fairly parallel throughout the whole of the folding process, except in the central third of the book, where they arrange themselves into a beautiful sheaf-like form, showing how much the leaves of the book have sheared or slidden over each other in this central portion. It will also be seen when the S is complete that the book has been forced into a third of its former breadth. It is clear that the wave which the book now forms must be regarded as made up of three sections: viz. a section forming the outside of the trough on the one side, and a section forming the outside of the arch on the other, and a central or common section, which may be regarded either as uniting or dividing the other two.

As this experiment gives us a fair representation of what takes place in a geological fold, we see at a glance that the geologist is forced to divide his fold into three parts—an arch limb, a trough limb, and a middle limb—which last we may call the *copula* or the *septum*, according as we regard it as connecting or dividing the other two. Our note-book experiment shows us also that in the trough limb and the arch limb the leaves or layers undergo scarcely any change of relative position beyond taking on the growing curvature of the wave. But the layers in the central part, or *septum*, undergo sliding and shearing. It will be found also, by gripping the unbound parts of the book firmly and practising the folding in different ways, that this *septum* is also a region of warping and twisting. This simple experiment should be practised again and again until all these points are apparent, and the various stages of the folding process become clear; the surface of the book being forced first into a gentle arch-like rise with a corresponding trough-like fall; then stage by stage the arch should be pushed over on to the trough until the surfaces of the two are in contact and the book can be folded no further.

In the structure of our modern mountain ranges we discover the most beautiful illustrations of the bending and folding of the rocky formations of the earth-crust. The early results of Rogers among the Alleghanies, of Lory and Favre in the Western Alps, have been greatly extended of late years by the discoveries of Heim and Baltzer in the Central Alps, of Bertrand in Provence, of Margerie in Languedoc, of Dutton and his colleagues in the western ranges of America, and of Peach and Horne and others in the older rocks of Britain. The light these researches throw upon the phenomena of mountain structure will be found admirably summarized and discussed in the works of Leconte, of Dana, of Daubrée, of Reade, of Heim, and finally in the magnificent work of Suess, the "Antlitz der Erde," of which only the first two volumes have yet appeared.

Looking first at the mountain fold in its simplest form as that of a bent rock-plate, composed of many layers which have been forced into two similar arc-like forms, the convexities of which are turned, the one upwards and the other downwards, we find in the present mountain ranges of the globe every kind represented. We commence with one in which the arch is represented merely by a gentle swell of the rock sheet, and the trough by an answering shallow depression, the two shading into each other in an area of contrary flexure. From this type we pass insensibly to others in which we see that the sides of the common limb or septum are practically perpendicular. From these we pass to folds in which the twisted common limb or septum overhangs the vertical, and so on to that final extreme, where the arch limb has been pushed completely over on to the trough limb, and all three members, as in our note-book experiment, are practically welded into one conformable solid mass.

Although the movements of these mountain folds are slow and insensible, and only effected in the course of ages, so that little or no evidence of the actual movement of any single one of them has been detected since they were first studied, yet it is perfectly plain that when we regard them collectively, we have here crust folds in every stage of their existence. Each example in itself represents some one single stage in the lifetime of a single fold. They are simply crust folds of different ages. Some are, as it were, just born; others are in their earliest youth. Some have attained their majority, some are in the prime of life, and some are in the decrepit stages of old age. Finally, those in which all three members—arch limb, trough limb, and septum—are crushed together into a conformable mass, are dead. Their life of individual movement is over. If the earth pressure increases the material which they have packed together may of course form a passive part of a later fold, but they themselves can move no more.

In many cases, due partly to the action of longitudinal pressures, the septum becomes reduced to a *plane* of contrary motion, namely—the over-fault, or thrust-plane, and the arch limb and the trough limb slide past each other as two solid masses. But here we have no longer a fold, but a fault.

We see that every mountain fold commences first as a gentle alternate elevation and depression of one or more of the component sheets of the geological formations which make up the earth-crust. This movement is due apparently to the tangential thrusts set up by the creeping together, as it were, of those neighbouring and more resistant parts of the earth-crust which lie in front of and behind the moving wave. Yielding slowly to these lateral thrusts the crest of the fold rises higher and higher, the trough sinks lower and lower, the central common limb or septum grows more and more vertical and becomes more and more strained, sheared, and twisted. As this middle limb yields, the rising arch part of the fold is forced gradually over on to the sinking trough, until at last all three members come into conformable contact and further folding as such is impossible. Movement ceases, the fold is dead.

We see also from our note-book experiment that the final result of the completion of the fold is clearly to strengthen up and consolidate that part of the crust plate to the local weakness of which it actually owed its origin and position. The fold has by its life-action theoretically trebled the thickness of that part of the earth-plate in which its dead remains now lie. If the lateral pressure goes on increasing and the layers of the earth-crust again begin to fold in the same region, the inert remains of the first fold can only move as a passive part of a newer fold: either as a part of the new arch-limb, the new trough-limb, or the new septum. As each younger and younger fold formed in this way necessarily includes a more resistant, and therefore a thicker, broader, and deeper sheet of the earth-crust, we have here the phylogenetic evolution of a whole family of crust folds, each successive member of which is of a higher grade than its immediate predecessor.

But it very rarely happens that the continuous plate in which any fold is imbedded is able to resist the crust creep until the death of the first fold. Usually, long before the first simple fold is completed, a new and a parallel one rises in front of it on the side of the trough limb, and the two grow, as it were, henceforward side by side. But the younger fold, being due to a greater pressure than the older, must of necessity be of a higher specific grade, and the two together form a generic fold in common.

Our present mountain systems are all constituted of several families of folds, all formed in this way, of different gradations of size, of different dates of origin, and of different stages of life evolution; and in each family group the members are related to each other by this natural genetic affinity.

Sometimes the new folds are formed in successive order on one side of the first fold, and then we have our unilateral (or so-called unsymmetrical) mountain groups, like those of the Jura and the Bavarian Alps. Sometimes they are formed on both sides of the original fold, and then we have our bilateral (or so-called symmetrical) ranges, like the Central Alps. In both cases the septa of the aged or dead folds are of necessary all directed inwards towards the primary fold. If, therefore, they originate only on one side of the fold, our mountain group looks unsymmetrical, with a very steep side opposed to a gently sloping side. If they grow on both sides of the original fold, we have the well-known "fan structure" of mountain ranges. In this case the whole complex range is seen at a glance to be a vast compound arch of the upper layers of the earth-crust, keyed up by the material of the dead or dying folds, which by the necessities of the case constitute mighty wedges whose apices are directed inwards towards the centre of the system. But a complete arch of this kind is in reality not a single fold, but a double one, with a septum on both sides of it; and it requires two troughs, one on each side of it, as its natural complement. The so-called unsymmetrical ranges, therefore, which are constituted merely of arch limb, trough limb, and septum, are locally the more natural and the more common.

It is clear that in the lifetime of any single fold its period of greatest energy and most rapid movement must be that of middle life. In early youth the lateral pressure is applied at a very small angle, and the tangential forces act therefore under the most disadvantageous circumstances. In the middle life of the fold the arch limb and the trough limb stand at right angles to the septum, and the work of deformation is then accomplished under the most favourable mechanical conditions and with the greatest rapidity. That is to say, the activity of the fold and the rate of movement of the septum, like the speed of the storm wind, varies directly as the gradient.

In our note-book experiment we observed that little or no change took place in the arch limb and trough limb, while the septum became remarkably sheared and twisted. The same is the case in nature, but here we have to recollect that these moving mountain folds are of enormous size, indeed actual mountains in themselves. These great arches, scores of miles in length, thousands of feet in height and thickness, must of necessity be of enormous weight, capable of crushing to powder the hardest rocks over which they move, while the thrust which drives them forward is practically irresistible. It is plain, therefore, that while the great arch limb and the trough limb of one of these mighty folds move over and under each other from opposite directions, they form together an enormous machine, composed of two mighty rollers or millstones, which mangle, roll, tear, squeeze, and twist the rocky material of the middle limb or septum, which lies jammed in between them, into a laminated mass. This deformed material, which is the characteristic product of the mountain-making forces, is, of course, made up of the stuff or the original middle limb of the fold; and whether we call it breccia, mylonite, phyllite, or schist, although it may be composed of sedimentary stuff, it is certainly no longer a *stratified* rock; and though it may have been originally purely igneous material, it is certainly no longer *volcanic*. It is now a manufactured article made in the great earth mill.

These mountain folds, however, are merely the types of folds and wrinkles of all dimensions which affect the rock formations of the earth-crust. Within the mountain chains themselves we can follow them fold within fold, first down to formations, then to strata, then to laminæ, till they disappear at last in microscopic minuteness beyond the limits of ordinary vision. Leaving these, however, for the moment, let us travel rather in the opposite direction, for these mountain folds are by no means the largest known to the stratigraphical geologist. Look at any geological section crossing the continent of North America, and it will be found that the whole of the Rocky Mountain range on its western side and the Alleghany range on the east are really two mighty compound geological anticlines, while the broad sag of the Mississippi Basin is actually a compound geological syncline made up of the whole pile of the geological formations. That is to say, the continent of North America is composed of a pair of geological folds, the two arches of which are represented by the Rockies on the one side and the Alleghanies on the other, while the intermediate Mississippi syncline is the common property of both. Here, then, we reach a much higher grade of fold than the orographic or mountain-making fold, viz. the plateau-making fold or the semi-continental fold, which, because of its enormous breadth, must include a very much thicker portion of the earth-crust than the ordinary orographic fold itself.

But which must be the real middle limbs of these two American folds, those septal areas where most work is being done and the motion is greatest?

Taught by what we have already learned of the mountain wave the answer is immediate and certain. They must be on the steeper sides of each of the two folds, namely, those which face the ocean. How perfectly this agrees with the geological facts goes without saying. It is on the steep Pacific side of the western fold that the crushing and crumpling of its rocks is the greatest. It is on the Atlantic side of the eastern fold that the contortion and the metamorphism of its rocks are at their maximum, while in the common and gently sloping trough of both folds, namely, the intermediate Mississippi Valley, the entire geological sequence remains practically unmodified throughout.

Again, which of these two American folds should be the more active at the present day? Taught by our study of the mountain wave the answer again is immediate and conclusive. It must be that fold whose septum has the steeper gradient. Geology and geography flash at once into combination. The steeper Pacific septum of the western fold from Cape Horn almost to

Alaska is ablaze with volcanoes, while the gently inclined Atlantic septum of the eastern fold from Greenland to Magellan Straits shows none, except on the outer edge of the Antilles, in the very region where the slope of the surface is the steepest. We see at a glance that the vigour of these two great continental folds, like those of our mountain waves, varies directly as the surface gradient of the septum.

But the geographical surface of North America, considered as a whole, is in reality that of a double arch, with a sag or common trough in the middle. We have seen already that this double arch must be regarded as the natural complement of the equally double Atlantic trough. Here, then, if the path of analogy we have hitherto so triumphantly followed up to this point is still to guide us, the basin of the Atlantic must be, not only in appearance, but in actuality, formed of two long minor folds of the same grade as the two that form the framework of America, but with their members arranged in reverse order. If so, their submarine septa ought also to be lines of movement and of volcanic action. And this is again the case. The volcanic islands of the Azores and St. Helena lie not exactly on the longitudinal crests of the mid-oceanic *Challenger* ridge, but upon its bounding flanks.

But we have not yet, however, finished with our simple fold. If we draw a line completely round the globe, crossing the Atlantic basin at its shallowest, between Cape Verde to Cape St. Roque, and continued in the direction of Japan, where the Pacific is at its deepest, as the trace of a great circle we find that we have before us a crust fold of the very grandest order. We have one mighty continental arch stretching from Japan to Chili, broken medially by the sag of the Atlantic trough, and this great terrestrial arch stands directly opposed to its natural complement, the great trough of the Pacific, which is bent up in the middle by the mightiest of all the submarine buckles of the earth-crust, on which stand the oceanic islands of the central Pacific.

But if this be true, then the septum of all septa on our present earth-crust must cross our grandest earth fold where the very steepest gradient occurs along this line, and it must constitute the centre-point of the moving earth fold, and of greatest present volcanic activity. And where is this most sudden of all depressions? Taught once more by our geological fold, the answer is instantaneous and incontrovertible. It is on the shores of Japan, the region of the mightiest and most active of all the living and moving volcanic localities on the face of our globe.

But the course of the line which we indicated as forming our grandest terrestrial fold returns upon itself. It is an endless fold, an endless band, the common possession of two sciences. It is geological in origin, geographical in effect. It is the *wedding-ring* of geology and geography, uniting them at once and for ever in indissoluble union.

Such an endless fold, again, must have an endless septum, which, in the nature of things, must cross it twice. Need I point out to the merest tyro in these wedded sciences that if we unite the Old and New Worlds and Australia, with their intermediate sags of the Antarctic and Indian Oceans, as one imperial earth arch, and regard the unbroken watery expanse of the Pacific as its complementary depression, then the circular coastal band of contrary surface flexure between them should constitute the moving master septum of the earth crust. This is the "Volcanic girdle of the Pacific," our "Terrestrial Ring of Fire."

Or, finally, if we rather regard the compact arch of the Old World itself as the natural complement of the broken Indo-Pacific depression, then the most active and continuous septal band of the present day should divide them. Again our law asserts itself triumphantly. It is the great volcanic and earthquake band on which are strung the Festoon Islands of Western Asia, the band of Mount St. Elias, the Aleutians, Kamtchatka, the Kuriles, the band of Fusijama, Krakatoa, and Sangir. The rate of movement of the earth's surface doubtless everywhere varies directly as the gradient.

We find, therefore, that even if we restrict our observations to the most simple and elementary conception of the rock fold as being made up of arch-limb, trough-limb, and twisting but still continuous septum, we are able to connect, in one unbroken chain, the minutest wrinkle of the finest lamina of a geological formation with the grandest geographical phenomena on the face of our globe.

We find, precisely as we anticipated, that the wave-like surface of the earth of the present day reflects in its entirety the wave-like arrangement of the geological formations below. On the land we find that the surface arches and troughs answer precisely to the grander regional anticlines and synclines of the subterranean sedimentary sequence; and it may, I believe, be regarded as certain that the submarine undulations have a similar or complementary relationship. We find in the new geology, as Hutton found in the old, that geography and geology are one. We find, as we suspected, that the physiognomy of the face of our globe is an unerring index of the solid personality beneath. It bears in its lineaments the characteristic family features and the common traits of its long line of geological ancestors.

Such, it seems to me, is an imperfect account of the introductory paragraphs of that great chapter in the New Geology now in course of interpretation by geologists of the present day; and we have translated them exactly in the old way by the aid of the only living geological language, the language of present natural phenomena, and I doubt not that sooner or later the rest of this great chapter will be read by the same simple means.

I have confined myself to-day to the discussion of the characteristics of the simple geological fold as reduced to its most elementary terms of arch, trough, and unbroken septum; for this being clearly understood, the rest naturally follows. But this twisted plate is really the key which opens the entire treasure-house of the New Geology in which lie spread around in bewildering confusion facts, problems, and conclusions enough to keep the young geologist and other scientific men busily at work for many a long year to come.

Into this treasure-house I often wander myself, in the few leisure hours that I can steal from a very busy professional life; and out of it I bring now and again heresies that sometimes amuse and sometimes horrify my geological friends. As you have so patiently listened to what I have already said, perhaps you will permit me in a few final sentences to indicate in brief some of those novelties which I see already more or less clearly, and a few of those less novel points on which it appears to me that more light is wanted. My excuse is twofold—first, to furnish material for work and controversy to the young geologists; and second, to obtain aid for myself from workers in other walks of science.

The account of the simple rock-fold I have already given you is of the most elementary kind. It presupposes merely the yielding to tangential pressure from front and back, combined with effectual resistance to sliding. But in the layers of the earth-crust there is always, in addition, a set of tangential pressures theoretically at right angles to this. The simple fold becomes a *folded fold*, and the compound septum twists not only vertically but laterally. On the surface of the globe this double set of longitudinal and transverse waves is everywhere apparent. They account for the detailed disposition of our lands and our waters, for our present coastal forms, for the direction, length, and disposition of our mountain-ranges, our seas, our plains, and lakes. The compound arch becomes a dome, its complementary trough becomes a basin. The elevations and depressions, major and minor, are usually twinned, like the twins of the mineralogist, the complementary parts being often inverted, and turned through 180° (compare Italy with the Po-Adriatic depression). Every upward swirl and eddy has its answering downward swirl. The whole surface of our globe is thus broken up into fairly continuous and paired masses, divided from each other by moving areas and lines of mountain making and crust movement, so that the surface of the earth of the present day seems to stand midway in its structure and appearance between those of the sun and the moon, its eddies wanting the mobility of those of the one and the symmetry of those of the other. In the geology of the earth-crust, also, the inter-crossing of the two sets of folds, theoretically at right angles to each other, gives rise to effects equally startling. It lies at the origin of the thrust-plane or overfault, where the septal region of contrary motion in the fold becomes reduced to, or is represented by, a *plane* of contrary motion. It allows us to connect together under one set of homologies folds and faults. The downthrow side of the fault answers to the trough, the upthrow side to the arch, of our longitudinal fold; while the fault-plane itself represents the septal area reduced to zero. The node of the fault, and the alternation and alteration of throw, are due to the effects of the transverse folding.

These transverse folds of different grades, which affect different layers of the earth-crust differentially, account also for the formation of laccolites, of granitic cores, and of petrological provinces; and they enable us also to understand many of the phenomena of metamorphism.

Of the folds of the third order I shall here say nothing; but I must frankly admit that the primal cause of all this tangential movement and folding stress is still as mysterious to me as ever. I incline to think that it is due to many causes—tidal action, sedimentation, and many others. I cannot deny, however, that it may be *mainly* the result of the contraction in diameter of our earth, due to the loss of its original heat into outer space? For everywhere we find evidences of symmetrical crushing of the earth-crust by tangential stresses. Everywhere we find proofs that different layers of that crust have been affected differentially, and the outer layers have been folded the most. We seem to be dealing not so much with a solid globe as with a globular shell composed of many layers.

Is it not just possible after all that, as others have suggested, our earth is such a hollow shell, or series of concentric shells, on the surface of which gravity is at a maximum, and in whose deepest interior it is non-existent? May this not be so also in the case of the sun, through whose spot-eddies we possibly look into a hollow interior? If so, perhaps our present nebulæ may also be hollow shells formed of meteorites; on the surfaces of these shells the fiery spirals we see would be the swirls which answer to the many twisting crustal septa of the earth. Our comets, too, in this case might be elongated ellipsoids, whose visible parts would be merely interference phenomena or sheets of differential movement.

In this case we have represented before us to-day all the past of our earth as well as its present. Uniformity and evolution are one.

Thus from the microscopic septa of the laminæ of the geological formations we pass outwards *in fact* to these moving septa of our globe, marked on land by our new mountain-chains, and on our shores by our active volcanoes. Thence we sweep, *in imagination*, to the fiery eddies of the sun, and thence to the glowing swirls of the nebulæ; and so outwards and upwards to that most glorious septum of all the visible creation, the radiant ring of the Milky Way.

Prof. George Darwin, in his address to the section of mathematical and physical science at the meeting of the British Association at Birmingham in 1886, with all the courage of genius, and the authority of one of the sons of the prophets, acknowledged that it seems as likely that "meteorology and geology will pass the word of command to cosmical physics as the converse." Behind this generous admission I shelter myself. But I feel absolutely confident that long after the physicists may have swept away these provisional astronomical suggestions as "the baseless fabric of a vision," there will still remain in the treasure-house of the geological fold a wealth of abundant material for the use of the mathematician, the physicist, the chemist, the mineralogist, and the astronomer, of the deepest interest and of the highest value.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY ALEXANDER MACALISTER, M.D., F.R.S., PROFESSOR OF ANATOMY IN THE UNIVERSITY OF CAMBRIDGE, PRESIDENT OF THE SECTION.

ON an irregular and unfenced patch of waste land, situated on the outskirts of a small town in which I spent part of my boyhood, there stood a notice board bearing the inscription, "A Free Coup," which, when translated into the language of the Southron, conveyed the intimation, "Rubbish may be shot here." This place, with its ragged mounds of unconsidered trifles, the refuse of the surrounding households, was the favourite playground of the children of the neighbourhood, who found a treasury of toys in the broken tiles and oyster-shells, the crockery and cabbage-stalks, which were liberally scattered around. Many a make-believe house and road, and even village, was constructed by these mimic builders out of this varied material, which their busy little feet had trodden down until its undulated surface assumed a fairly coherent consistence.

Passing by this place ten years later I found that its aspect had changed; terraces of small houses had sprung up, mushroom-like, on the unsavoury foundation of heterogeneous refuse. Still more recently I notice that these in their turn have been swept away, and now a large factory, wherein some of the most ingenious productions of human skill are constructed, occupies the site of the original waste.

This commonplace history is, in a sense, a parable in which is set forth the past, present, and possible future of that accumulation of lore in reference to humanity to which is given the name Anthropology, and for the study of which this Section of our Association is set apart. At first nothing better than a heap of heterogeneous facts and fancies, the leavings of the historian, of the adventurer, of the missionary, it has been for long, and alas is still, the favourite playground of *dilettanti* of various degrees of seriousness. But upon this foundation there is rapidly rising a more comely superstructure, fairer to see than the original chaos, but still bearing marks of transitoriness and imperfection, and I dare hazard the prediction that this is destined in the course of time to give place to the more solid fabric of a real Science of Anthropology.

We cannot yet claim that our subject is a real science in the sense in which that name is applied to those branches of knowledge, founded upon ascertained laws, which form the subjects of most of our sister Sections; but we can justify our separate existence, in that we are honestly endeavouring to lay a definite and stable foundation, upon which in time to come a scientific Anthropology may be based.

The materials with which we have to do are fully as varied as were those in my illustration, for we as anthropologists take for our motto the sentiment of Chremes, so often quoted in this Section, *humani nihil a nobis alienum putamus*, and they are too often fully as fragmentary. The bones, weapons, and pottery which form our only sources of knowledge concerning prehistoric races of men, generally come to us as much altered from their original forms as are the rusty polyhedra which once were the receptacles for biscuits or sardines. The traditions, customs, and scraps of folk-lore which are treasures to the constructive anthropologist, are usually discovered as empty shells, in form as much altered from their original conditions as are those smooth fragments of hollow white cylinders which once held the delicate products of the factory of Keiller or Cairns.

I have said that Anthropology has not yet made good its title to be ranked as an independent science. This is indicated by the difficulty of framing a definition at the same time comprehensive and distinctive. Mr. Galton characterizes it as the study of what men are in body and mind, how they came to be what they are, and whither the race is tending; General Pitt-Rivers, as the science which ascertains the true causes for all the phenomena of human life. I shall not try to improve upon these definitions, although they both are manifestly defective. On the one side our subject is a branch of biology, but we are more than biologists compiling a monograph on the natural history of our species, as M. de Quatrefages would have it. Many of the problems with which we deal are common to us and to psychologists; others are common to us and to students of history, of sociology, of philology, and of religion; and, in addition, we have to treat of a large number of other matters æsthetic, artistic, and technical, which it is difficult to range under any subordinate category.

In view of the encyclopædic range of knowledge necessary for the equipment of an accomplished anthropologist, it is little wonder that we should be, as we indeed are, little better than smatterers. Its many-sided affinities, its want of definite limitation, and the recent date of its admission to the position of an independent branch of knowledge, have hitherto caused Anthropology to fare badly in our Universities. In this respect, however, we are improving, and now in the two great English Universities there are departments for the study of the natural history of man and of his works.

Out of the great assemblage of topics which come within our sphere, I can only select a few which seem at present to demand special consideration. The annual growth of our knowledge is chiefly in matters of detail which are dull to chronicle, and the past year has not been fertile in discoveries bearing on those great questions which are of popular interest.

On the subject of the antiquity of man there are no fresh discoveries of serious importance to record. My esteemed predecessor at the Leeds meeting two years ago, after reviewing the evidence as to the earliest traces of humanity, concluded his survey with the judgment, "On the whole, therefore, it appears to me that the present verdict as to tertiary man must be in the form of 'Not Proven.'" Subsequent research has not contributed any new facts which lead us to modify that finding. The most remarkable of the recent discoveries under this head is that of the rude implements of the Kentish chalk-plateau described by Professor Prestwich; but while these are evidently of archaic types, it must be admitted that there is even yet room for difference of opinion as to their exact geological age.

Neither has the past year's record shed new light on the darkness which enshrouds the origin of man. What the future may have in store for us in the way of discovery we cannot forecast; at present we have nothing but hypothesis, and we must still wait for further knowledge with the calmness of philosophic expectancy.

I may, however, in this connection refer to the singularly interesting observations of Dr. Louis Robinson on the prehensile power of the hands of children at birth, and to the graphic pictures with which he has illustrated his paper. Dr. Robinson has drawn, from the study of the one end of life, the same conclusion which Mr. Robert Louis Stevenson deduced from the study of his grandfather, that there still survive in the human structure and habit traces of our probably arboreal ancestry.

Turning from these unsolved riddles of the past to the survey of mankind as it appears to us in the present, we are confronted in that wide range of outlook with many problems well nigh as difficult and obscure.

Mankind, whenever and however it may have originated, appears to us at present as an assemblage of tribes, each not necessarily homogeneous, as their component elements may be derived from diverse genealogical lines of descent. It is much to be regretted that there is not in our literature a more definite nomenclature for these divisions of mankind, and that such words as *race*, *people*, *nationality*, *tribe*, and *type* are often used indiscriminately as though they were synonyms.

In the great mass of knowledge with which we deal there are several collateral series of facts, the terminologies of which should be discriminated. In the first place there are those ethnic conditions existing now, or at any other point in time, whereby the individuals of mankind are grouped into categories of different comprehension, as *clans* or families, as *tribes* or groups of allied clans, and as *nations*, the inhabitants of restricted areas under one political organization. This side of our subject constitutes Ethnology.

In the second place, the individuals of mankind may be regarded as the descendants of a limited number of original parents, and consequently each person has his place on the genealogical tree of humanity. As the successive branches became in their dispersion subjected to the influences of diverse environments, they have eventually differentiated in characteristics. To each of these subdivisions of the phylum thus differentiated the name *race* may appropriately be restricted, and the sum of the peculiarities of each race may be termed *race-characters*. This is the phylogenetic side of Anthropology, and its nomenclature should be kept clearly separate from that of the ethnological side. The great and growing literature of Anthropology consists largely of the records of attempts to discover and formulate these distinctive race-characters. *Race* and *tribe* may be terms of equal extension, but the standpoint from which these categories are viewed is essentially different in the two cases.

There is yet a third series of names in common use in Descriptive Anthropology. The languages in use among men are unfortunately numerous, and as the component individuals in each community usually speak a common language, the mistake is often made of confounding the tribal name with that of the tribal language. Sometimes these categories are co-extensive; but it is not always so, for it is a matter of history that communities have been led to adopt new languages from considerations quite independent of phylogenetic or ethnic conditions. These linguistic terms should not be confounded with the names in either of the other series, for, as my learned predecessor once said in a presidential address, it is as absurd to speak of an Aryan skull as it would be to say that a family spoke a brachycephalic language.

In the one clan there may be, by intermarriage, the representatives of different races; in the one nation there may be dissimilar tribes, each derived by composite lines of ancestry from divergent phyla, yet all speaking the same language.

We have an excellent illustration of the confusion resulting from this disregard of precision in the case of the word *Celtic*, a term which has sometimes been employed as an ethnic, sometimes as a phylogenetic, and sometimes as a linguistic species. In the last-named sense, that to which I believe the use of the name should be restricted, it is the appropriate designation of a group of cognate languages spoken by peoples whose physical characters show that they are not the descendants of one common phylum in the near past. There are fair-haired, long-headed families in Scotland and Ireland; fair, broad-headed Bretons; dark-haired, round-headed Welshmen; and dark-haired, long-headed people in the outer Hebrides, McLeans, "Sancho Panza type"—men obviously of different races, who differ not only in colour, stature, and skull-form, but whose traditions also point to a composite descent, and yet all originally speaking a Celtic tongue. The use of the word *Celtic* as if it were the name of a phylogenetic species has naturally led to hopeless confusion in the attempts to formulate race-characters for the Celtic skull—confusions of a kind which tend to bring physical anthropology into discredit. Thus Retzius characterizes the Celtic crania as being dolichocephalic, and compares them with those of the modern Scandinavians. Sir Daniel Wilson considers the true Celtic type of skull as intermediate between the dolichocephalic and the brachycephali; and Topinard figures as the typical Celtic skull that of an Auvergnat, extremely brachycephalic, with an index of 85!

Our traditional history tells that we, the Celtic-speaking races of Britain, are not of one common ancestry, but are the descendants of two distinct series of immigrants, a British and a Gaelic. Whatever may have been the origin of the former, we know that the latter are not homogeneous, but are the mixed descendants of the several Fomorian, Nemedian, Firbolg, Tuatha de Danaan, and Milesian immigrations, with which has been combined in later times a strong admixture of Scandinavian blood. It is now scarcely possible to ascertain to which of these component strains in our ancestry we owe the Celtic tongue which overmastered and supplanted the languages of the other tribes, but it is strictly in accordance with what we know of the history of mankind that this change should have taken place. We have instances in modern times of the adoption by conquered tribes of the language of a dominant invading people. For example, Mr. Hale has lately told us that the speech of the Hupas has superseded the languages of those Californian Indians whom they have subdued. In like manner, nearer home, the English language is slowly but surely supplanting the Celtic tongues themselves.

We may here parenthetically note that what has been observed in the case of language has also taken place in reference to ritual and custom. Observances which have a history and a meaning for one race have, in not a few instances, been adopted by or imposed upon other races to whom they have no such significance, and who in incorporating them give to them a new local colour. These pseudomorphs of the earlier cultures are among the most perplexing of the problems which the student of comparative religion or folk-lore has to resolve.

But we want more than a perfect nomenclature to bring Anthropology into range with the true sciences. We need a broader basis of ascertained fact for inductive reasoning in almost all parts of our subject; we want men trained in exact method who will work patiently at the accumulation, verification, and sorting of facts, and who will not prematurely rush into theory. We have had enough of the untrained writer of papers, the jerry-builder of unfounded hypotheses whose ruins cumber our field of work.

The present position of our subject is critical and peculiar; while on the one hand the facilities for anthropological research are daily growing greater, yet in some directions the material is diminishing in quantity and accessibility. We are accumulating in our museums treasures both of the structure and the works of man, classified according to his distribution in time and space; but at the same time some of the most interesting tribes have vanished, and others are rapidly disappearing or becoming fused with their neighbours. As these pass out of existence we, with them, have lost their thoughts, their tongues, and their traditions; for even when they survive, blended with other races, that which was a religion has become a fragmentary superstition, then a nursery tale or a child's game, and is destined finally to be buried in oblivion. The unifying influences of commerce, aided by steam and electricity, are effectually effacing the landmarks between people and people, so that if we are to preserve in a form fit for future use the shreds which remain of the myths, folk-lore, and linguistic usages of many of the tribes of humanity, we must be up and doing without delay. It is on this account that systematic research such as that which Mr. Risley has advocated with regard to the different races of India is of such pressing and urgent importance. It is for this reason likewise that we hail with pleasure the gathering of folk-lore while yet it survives, and welcome such societies for the purpose as the Folk-lore Congress recently inaugurated.

I have said that in the department of Physical Anthropology our facilities for research are increasing. The newly-founded anthropometric laboratories are beginning to bring forth results in the form of carefully compiled statistical tables, embodying the fruits of accurate observations, which are useful as far as they go. Were these extended in their scope the same machinery might easily gather particulars as to the physical characters of the inhabitants of different districts, which would enable the anthropologist to complete in a systematic manner the work which Dr. Beddoe had so well begun. I would commend this work to the consideration of the provincial university colleges, especially those in outlying districts.

Of all the parts of the human frame, the skull is that upon which anthropologists have in the past expended the most of their time and thought. We have now, in Great Britain alone, at least four collections of skulls, each of which includes more than a thousand specimens, and in the other great national and university museums of Europe there are large collections available for study and comparison.

Despite all the labour that has been bestowed on the subject, craniometric literature is at present as unsatisfactory as it is dull. Hitherto observations have been concentrated on cranial measurements as methods for the discrimination of the skulls of different races. Scores of lines, arcs, chords, and indexes have been devised for this purpose, and the diagnosis of skulls has been attempted by a process as mechanical as that whereby we identify certain issues of postage-stamps by counting the nicks in the margin. But there is underlying all these no unifying hypothesis, so that when we, in our sesquipedalian jargon describe an Australian skull as microcephalic, phænozygous, tapeino-dolichocephalic, prognathic, platyrhine, hypselopalatine, leptostaphyline, dolichuranic, chamæprosopic, and microseme, we are no nearer to the formulation of any philosophic concept of the general principles which have led to the assumption of these characters by the cranium in question, and we are forced to echo the apostrophe of Von Török, "Vanity, thy name is Craniology."

It was perhaps needful in the early days of the subject that it should pass through the merely descriptive stage; but the time has come when we should seek for something better, when we should regard the skull not as a whole complete in itself, nor as a crystalline geometrical solid, nor as an invariable structure, but as a marvellously plastic part of the human frame, whose form depends on the co-operation of influences, the respective shares of which in moulding the head are capable of qualitative if not of quanitative analysis. Could measurements be devised which would indicate the nature and amounts of these several influences, then, indeed, would craniometry pass from its present empirical condition, and become a genuine scientific method. We are yet far from the prospect of such an ideal system, and all practical men will realize the immense, but not insuperable, difficulties in the way of its formulation.

In illustration of the profound complexity of the problem which the craniologist has to face, I would ask your indulgence while I set out a few details to show the several factors whose influence should be numerically indicated by such a mode of measurement.

The parts composing the skull may be resolved into four sets: there is, first, the brain-case; secondly, the parts which subserve mastication and the preparation of the food for digestion; thirdly, the cavities containing the organs of the senses of hearing, sight, and smell; and fourthly, those connected with the production of articulate speech. If our measurements are to mean anything, they should give us a series of definite numbers indicating the forms, modifications, and relative size of these parts, and their settings with regard to each other and to the rest of the body.

To take the last point first, it needs but a small consideration to show that the parts of the skull are arranged above and below a certain horizontal plane, which is definite (although not easily ascertained) in every skull, human or animal. This is the plane of vision. The familiar lines of Ovid—

> Pronaque cum spectent animalia cetera terram,
> Os homini sublime dedit; cœlumque tueri
> Jussit, et erectos ad sidera tollere vultus—

are anatomically untrue, for the normal quadruped and man alike, in their most natural position, have their axis of vision directed to the horizon. Systems of measurement based upon any plane other than this are essentially artificial. There are at the outset difficulties in marking the plane accurately on the skull, and it is to be deplored that the anthropologists of different nations should have allowed themselves to be affected by extraneous influences, which have hindered their unanimous agreement upon some one definite horizontal plane in craniometry.

The Frankfort plane drawn through the upper margins of the auditory foramina and the lowest points of the orbital borders has the advantage of being easily traced and differs so little from the plane of vision that we may without substantial error adopt it.

The largest part of the skull is that which is at once the receptacle and the protector of the brain, a part which, when unmodified by external pressure, premature synostosis, or other adventitious conditions, owes its form to that of the cerebral hemispheres which it contains. Speaking in this city of George and Andrew Combe, I need not do more than indicate in this matter that observation and experiment have established on a firm basis certain fundamental points regarding the growth of the brain. The study of its development shows that the convolutioning of the cerebral hemisphere is primarily due to the connection, and different rate of growth, of the superficial layer of cells with the underlying layers of white nerve fibres; and that so far from the shape being seriously modified by the constraining influence of the surrounding embryonic skull, the form of the soft membranous brain-case is primarily moulded upon the brain within it, whose shape it may however be, to some extent, a secondary agent in modifying in later growth. We have also learned that, although in another sense from that of the crude phrenology of Aristotle, Porta, or Gall, the cerebrum is not a single organ acting as a functional unit, but consists of parts, each of which has its specific province; that the increase in the number of cells in any area is correlated with an increase in the size and complexity of pattern of the convolutions of that area; and that this in turn influences the shape of the enclosing shell of membrane and subsequently of bone.

The anatomist and the physiologist have worked hand in hand in the delimitation of these several functional areas, and pathology and surgery have confirmed what experimental physiology has taught. The topography of each part of the cerebrum, so important to the operating surgeon, should be pressed into the service of the anthropologist, whose measurements of the brain-case should have definite relation to these several areas. In the discussion which is to take place on this subject, I hope that some such relationships will be taken account of. This is not the place to work out in detail how this may be done; I only desire to emphasize the fundamental principle of the method.

The second factor which determines the shape of the individual skull is the size of the teeth. That these differ among different races is a matter of common observation; thus the average area of the crowns of the upper-jaw teeth in the male Australian is 1,536 sq. mm., while in the average Englishman it is only 1,286 sq. mm., less than 84 per cent. of that size.[1]

It is easy to understand how natural selection will tend to increase the size of the teeth among those races whose modes of feeding are not aided by the cook or the cutler; and how, on the other hand, the progress of civilised habits, assisted by the craft of the dentist, interferes with the action of selection in this matter among the more cultured races.

For larger teeth a more extensive alveolar arch of implantation is necessary; and as the two jaws are commensurately developed, the lower jaw of the macrodontal races exceeds that of the meso- or microdontal races in weight. Thus that of a male Australian exceeds that of the average Englishman in the proportion of 100 : 91.

To work this heavier jaw more powerful muscles are needed.

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[1] These and the succeeding averages are from my own measurements, taken from never less than ten individual cases.

In the average well-developed Englishman with perfect teeth the weight of the fleshy portion of the great jaw-muscles, masseters and temporals, is 60 grammes, while the weight of those as ascertained in two Australians was 74 grammes.

Correlated with this greater musculature a sharper definition of the areas for the attachments of the jaw-muscles is required. The muscular fascicles are approximately of uniform size in both microdonts and macrodonts, as the range of motion of the jaw differs little in different races; but when the skull is smaller on account of the smaller size of the brain which it contains, the temporal crest ascends higher on the side-wall. In the average Englishman the temporal crests at their points of greatest approximation anteriorly across the brows are 112 mm. apart, but in the Australian they are only separated by 103 mm.: the interstephanic distances in these two are respectively 132 and 114 mm.

The more powerful stroke of the mandibular teeth upon the anvil of the upper-jaw teeth in macrodonts renders necessarily a proportionally stronger construction of the bases of support for the upper alveolar arch. In any skull this arch requires to be solidly connected to the wall of the brain-case to which the shock of the impact is ultimately transmitted, and in order to protect from pressure the delicate intervening organs of sight and smell, the connection is accomplished by the reversed arches of the infraorbital margins with their piers, malar and maxillary, founded on the frontal angular processes. These foundations are tied together by the strong supraorbital ridge, so that the whole orbital edge is a ring, made up of the hardest and toughest bone in the skeleton.

A twofold modification of this arrangement is required in the macrodont skull. The bony circum-orbital ring becomes stronger, especially along its lateral piers; and also as the alveolar arch is longer, and consequently projects farther forward, its basis of support must be extended to meet and bear the malar and maxillary piers. But macrodonts are often microcephalic, and therefore the frontal region of the skull must be adjusted to form a foundation for this arch. In the average English male skull, held with its visual axes horizontal, a perpendicular dropped from the anterior-surface of the fronto-nasal suture will cut the plane of the alveolar arch between the premolar teeth or through the first premolar. In an Australian skull the perpendicular cuts the horizontal plane at the anterior border of the first molar teeth.

It is obvious, therefore, that to ensure firmness, the piers of the arches must be obliquely set; hence the jaw is prognathous, but it is also needful that the supra-orbital arcade should be advanced to meet and bear these piers, as the mandibular stroke is always vertical.

But the inner layer of the skull is moulded on the small frontal lobes of the brain, so this forward extension must affect only the much thicker and tougher outer table of the skull, which, at the period of the second dentition, here separates from the inner table, the interval becoming lined by an extension of the mucosa of the anterior ethmoidal cell. In this way an air space, the frontal sinus, is formed, whose development is thus directly correlated to the two factors of brain development and size of the teeth. If the frontal lobes are narrow in a macrodont skull, then the foundations of the outer or malar piers of the orbital arch must be extended outwards as well as forwards, the external angular process becoming a prominent abutment at the end of a strong low-browed supraorbital arch, whose overhanging edge gives to the orbital aperture a diminished vertical height.

The crania of the two most macrodont races of mankind, Australian and African, differ in the relation of the jaw to the frontal bone. In the microcephalic Australian, the maxillæ are founded upon the under side of the shelf-like projection of the outer table of the frontal, which juts out as a buttress to bear it. On the other hand the nasal processes of the mesocephalic negro ascend with greater obliquity to abut on the frontal, and have, by their convergence, crushed the nasal bones together, and caused their coalescence and diminution.

The crania of the two most microcephalic races present distinctive features of contrast along the same lines. The Bushman's skull is usually orthognathous, with a straight forehead and a shallow frontonasal recess, while the Australian skull is prognathous with heavy overhanging brows. These conditions are correlated to the mesodontism of the Bushman and the macrodontism of the Australian respectively.

In the course of the examination of the relations of brain development to skull growth, some interesting collateral points are elicited. The frontal bone grows from lateral symmetrical centres, which medially coalesce, union taking place usually between the second and sixth years of age. It has been noticed by anthropologists that metopism, as the anomalous non-union of the halves of this bone has been termed, is rare among microcephalic races, occurring only in about 1 per cent. among Australian skulls. Increased growth of the frontal lobes as the physical accompaniment of increased intellectual activity interposes an obstacle to the easy closure of this median suture, and so in such races as the ancient Egyptian, with a broader forehead, metopism becomes commoner, rising to 7 per cent. In modern civilised races the percentage ranges from 5 to 10. In following out the details of this enumeration, I have spoken as if the microdontal condition had been the primary one, whereas all the available evidence leads to show that the contrary was the case. The characters of all the early crania, Neanderthal Engis, and Cromagnon, are those of macrodonts. The progress has been from the macrodont to the microdont, as it probably was from the microcephalic to the macrocephalic.

The effects of the variations in size of the teeth are numerous and far-reaching. The fluctuation in the weight of the jaw depending on these variations has an important influence on the centre of gravity of the head, and affects the set of the skull on the vertebral column. This leads to a consequent change in the axes of the occipital condyles, and it is one of the factors which determines the size of the neck-muscles, and therefore the degree of prominence of the nuchal crests and mastoid process.

As the teeth and alveolar arches constitute a part of the apparatus for articulate speech, so these varieties in dental development are not without considerable influence on the nature of the sound produced. The necessarily larger alveolar arch of the macrodont is hypseloid or elliptical, more especially when it has to be supported on a narrow frontal region, and this is associated with a more extensive and flatter palatine surface. This, in turn, alters the shape of the mouth cavity, and is associated with a wide flat tongue, whose shape participates in the change of form of the cavity of which it is the floor. The musculature of the tongue varies with its shape and its motions, upon which articular speech depends, become correspondingly modified. For example, the production of the sharp sibilant S requires the approximation of the raised flexible edge of the tongue to the inner margins of the teeth behind the canines, and to the palatine margin close behind the roots of the canine and lateral incisor teeth. This closes the vocal tube laterally, and leaves a small lacuna about 5 mm. wide anterially, through which the vibrating current of air is forced. A narrow strip of the palate behind the medial halves of the median incisors bounds this lacuna above, and the slightly concave raised tongue-tip limits it below.

With the macrodont alveolar arch, and the correspondingly modified tongue, sibilation is a difficult feat to accomplish, and hence the sibilant sounds are practically unknown in all the Australian dialects.

It is worthy of note that the five sets of muscular fibres, whose function it is to close laterally the flask-like air-space between the tongue and the palate, are much less distinct and smaller in the tongues of the Australians which I have examined than in the tongues of ordinary Europeans.

There is a wide field open to the anatomical anthropologist in this investigation of the physical basis of dialect. It is one which requires minute and careful work, but it will repay any student who can obtain the material, and who takes time and opportunity to follow it out. The anatomical side of phonology is yet an imperfectly known subject, if one may judge by the crudeness of the descriptions of the mechanism of the several sounds to be found even in the most recent text-books. As a preliminary step in this direction we are in urgent need of an appropriate nomenclature and an accurate description of the muscular fibres of the tongue. The importance of such a work can be estimated when we remember that there is not one of the 260 possible consonantal sounds known to the phonologist which is not capable of expression in terms of lingual, labial, and palatine musculature.

The acquisition of articulate speech became possible to man only when his alveolar arch and palatine area became shortened and widened, and when his tongue, by its accommodation to the modified mouth, became shorter and more horizontally flattened, and the higher refinements of pronunciation depend for their production upon more extensive modifications in the same directions.

I can only allude now very briefly to the effects of the third set of factors, the sizes of the sense organs, on the conformation of the skull. We have already noted that the shape and the size of the orbital opening depend on the jaw as much as on the eye. A careful set of measurements has convinced me that the relative or absolute capacity of the orbital cavity is of very little significance as a characteristic of race. The microseme Australian orbit and the megaseme Kanaka are practically of the same capacity, and the eyeballs of the two Australians that I have had the opportunity of examining are a little larger than those of the average of mesoseme Englishmen.

The nasal fossæ are more variable in size than the orbits, but the superficial area of their lining and their capacity are harder to measure, and bear no constant proportion to the size of their apertures, because it is impossible without destroying the skull to shut off the large air sinuses from the nasal fossæ proper for purposes of measurement. Thus the most leptorhine of races, the Esquimaux, with an average nasal index of 437 has a nasal capacity of 55 c.c.m., equal to that of the platyrhine Australian, whose average is 54·5, and both exceed the capacity of the leptorhine English, which average about 50 c.c.m. There is an intimate and easily proved connection between dental size and the extent of the nasal floor and of the pyriform aperture.

These are but a few of the points which a scientific craniometry should take into consideration. There are many others to which I cannot now refer, but which will naturally occur to the thoughtful anatomist.

In this rapid review of the physical side of our subject the study of these race-characters naturally suggests the vexed question as to the hereditary transmission of acquired peculiarities. This is too large a controversy for us now to engage in, but in the special instances before us there are grounds for the presmption that these characters of microdontism and megacephaly have been acquired at some stage in the ancestral history of humanity, and that they are respectively correlated, with diminution of use in the one case, and increase of activity in the other. It is a matter of observation that these qualities have become hereditary, and the point at issue is not the fact, but the mechanism, of the transmission. We know that use or disuse affects the development of structure in the individual, and it is hard to believe that the persistent disuse of a part through successive generations does not exercise a cumulative influence on its ultimate condition.

There is a statement in reference to one of these characters which has gained an entrance into the text-books, to the effect that the human alveolar arch is shortening, and that the last molar tooth is being crowded out of existence. I have examined 400 crania of men of the long, and round-barrow races, Romano-British and early Saxon, and have not found among all these a single instance of absence of the third molar or of overcrowded teeth. On the other hand, out of 200 ancient Egyptian skulls, 9 per cent. showed displacement or disease, and 1½ per cent. show the want of one molar tooth. Out of 200 modern English skulls there was no third molar tooth in 1 per cent. So far this seems to confirm the current opinion.

Yet the whole history of the organism bears testimony to the marvellous persistence of parts in spite of contumely and disuse. Take, for example, the present position of the little toe in man. We know not the condition of this digit in prehistoric man, and have but little information as to its state among savage tribes at the present day, but we do know that in civilised peoples, whose feet are from infancy subjected to conditions of restraint, it is an imperfect organ—

> Of every function shorn
> Except to act as basis for a corn.

In 1 per cent. of adults the second and third joints have ankylosed, in 3 per cent. the joint between them is rudimentary, with scarcely a trace of a cavity, in 20 per cent. of feet the organ has lost one or more of its normal complement of muscles. But though shorn of some of its elements, and with others as mere shreds, the toe persists, and he would be a bold prophet who would venture to forecast how many generations of booted ancestry would suffice to eliminate it from the organization of the normal man.

Nevertheless, although it is difficult to demonstrate, in the present imperfect state of knowledge, the method whereby race-characters have originated, I think that the most of our anthropologists at least covertly adopt the philosophy of the ancient proverb, "The fathers have eaten sour grapes and the children's teeth are set on edge."

But there are other branches of anthropology of far greater interest than these simple problems upon which we have tarried so long. The study of man's intellectual nature is equally a part of our subject, and the outcomes of that nature are to be traced in the tripartite record of human progress which we call the history of culture. It is ours to trace the progress of man's inventions, and their fruits in language and the arts, the direct products of the human mind. It is also ours to follow the history of man's discovery of those secrets of nature to the unfolding of which we give the name of science. The task is also ours to inquire into that largest and most important of all sections of the history of culture which deals with the relation of human life to the unseen world, and to disentangle out of the complex network of religion, mythology, and ritual those elements which are real truths, either discovered by the exercise of man's reason, or learned by him in ways whereof science takes no account, from those adventitious and invented products of human fear and fancy which obscure the view of the central realities. In this country it matters less that our time forbids us to wander in these fascinating fields wherein the anthropologist loves to linger, as the munificent benefaction of Lord Gifford has ensured that there shall he an annual fourfold presentation of the subject before the students of our Scottish universities. There is no fear that interest in these questions will flag for want of diversity in the method of treatment or of varieties in the standpoints of the successive Gifford lecturers.

From the ground of our present knowledge we can but faintly forecast the future of Anthropology, when its range is extended by further research, and when it is purged of fancies, false analogies, and imperfect observations. It may be that there is in store for us a clearer view of the past history of man, of the place and time of his first appearance, of his primitive character, and of his progress. But has this knowledge, interesting as it may be for its own sake, any bearing on the future of mankind? Hitherto growth in knowledge has not been accompanied with a commensurate increase in the sum of human happiness, but this is probably due to the imperfection which characterises even our most advanced attainments. For example, while the medical and sanitary sciences, by their progress, are diminishing the dangers which beset humanity, they have also been the means of preserving and permitting the perpetuation of the weaklings of the race, which, had natural selection exercised its unhindered sway, would have been crushed out of existence in the struggle for life.

It is, however, of the essence of true scientific knowledge, when perfected, that it enables us to predict, and if we ever rise to the possession of a true appreciation of the influences which have affected mankind in the past, we should endeavour to learn how to direct these influences in the future that they shall work for the progress of the race. With such a knowledge we shall be able to advance in that practical branch of Anthropology, the science of education; and so to guide and foster the physical, intellectual, and moral growth of the individual that he will be enabled to exercise all his powers in the best possible directions. And lastly, we shall make progress in that kindred department, Sociology, the study of which does for the community what the science of education does for the individual. Is it a dream that the future has in store for us such an Anthropological Utopia?

PHYSICS AT THE BRITISH ASSOCIATION.

THE mathematicians and physicists of the British Association could not have had better accommodation than that which was placed at their disposal in Edinburgh. The physics lecture-room of a University, with its appropriate fittings and appliances, is their ideal environment. Almost all the leading British physicists were present, the chief absentee of note being Lord Rayleigh, and foreign men of science were well represented by such men as Profs. von Helmholz, Wiedemann, Ostwald, and Du Bois, from Germany; M. Guillaume, from France; Schoute, from Holland; and Michelson, from America.

The *Discussion on a National Physical Laboratory* was one of the most important.

The speakers were Oliver Lodge, Glazebrook, von Helmholz, Lord Kelvin, Rücker, Dr. John Ince, Fitzgerald, Stokes, Carey Foster, Ayrton, and the President.

Prof. Lodge opened the discussion by giving an outline of the work which might be done in such a laboratory. The work should include the accurate determination of physical constants, the maintenance of standards, and the issue or verification of certified copies, the continuous recording of certain special phenomena, the conduction of certain special experimental inquiries, more particularly such as might have to be carried on years or even centuries; the taking up and completing of lines of research already developed by amateurs (or even in well-equipped laboratories) to that point at which it was impossible for them, unaided, to proceed farther.

Mr. Glazebrook described the work done at the Cavendish Laboratory. A part of this work consists in the testing of units of electrical resistance and electromotive force. In many cases it is quite impossible (in view of the more proper work of the laboratory) to give the necessary time for the proper carrying out of this work—which should be undertaken by a National Laboratory.

Prof. von Helmholz stated that one of the chief causes for the setting up of the National Physical Laboratory at Berlin was the desire of the Government that mechanicians should be assisted in their work by means of properly conducted scientific research and superintendence. It was necessary also that proper headquarters should exist for the construction and control of standards. The directors are entirely free from any duties of teaching, no systematic instruction being given in the laboratory. A large part of the work done consists in standardizing of thermometers. In the first year of the institution 90,000 were tested. Electrical apparatus, steam engine indicators, and standard lights for gas and electric companies, are also tested; and a considerable amount of thermodynamical work is undertaken with a view to practical improvements. £2500 are spent annually upon apparatus and work alone, exclusive of salaries.

Lord Kelvin said that it was a matter of great importance to the nation that its artizans should have as good scientific direction for their work as the artizans of Germany have for theirs.

Prof. Rücker said that it was by no means gratifying that it was necessary to send thermometers to Paris in order that they should be compared with the air thermometer. It would be of great advantage to have a national institution worked largely in connection with the Royal Society.

Prof. Fitzgerald, among other things, said that he doubted if the House of Commons was sufficiently educated to understand that the advance of scientific work was of national value.

The Discussion on Nomenclature of Units was opened by Prof. Oliver Lodge on lines recently indicated in NATURE.

Dr. Hopkinson and Dr. Preece criticized the proposed changes, maintaining that the time had not yet arrived when they could be advantageously introduced, even if they were satisfactory, which was very questionable except in one or two cases.

Dr. du Bois also spoke in opposition to the proposed changes, remarking that, even if accepted in Britain, they certainly would not be favoured in Germany. The discussion then dropped.

The Report on Underground Temperature dealt with observations made in a boring at Wheeling, West Virginia. The well had been sunk by a company to a depth of 4500 feet. The company decided to abandon it at this stage; but on request the boring was continued to a much greater depth for the purpose of the scientific observations. During last summer observations of temperature were made at successive depths of 125 feet down to the bottom. The surface temperature being 51°, at a little more than 1000 feet below the surface, 68°·75 were registered. At 3000 feet and 4000 feet respectively, 87° and 102° were observed; and at the bottom of the well the temperature was 110°·15. The rate of increase grows with the depth. Between 1590 feet and 1835 feet, the average rate was 1° per 92 feet; between 1835 feet and 2486 feet it was 1° per 84·5 feet. This increased until at the foot the rate was 1° per 58 feet. The average rate was 1° per 72 feet.

Report on the Discharge of Electricity from Points.—As the result of the experiments made it was found that disturbing influences, which had little or no effect at the cathode, had a powerful effect when applied to the anode, so as even to prevent the passage of sparks. Experiments were also made with the view of determining the quantity of gas concerned in the passage of a given quantity of electricity.

Report on Electrical Standards.—The committee which submitted this report had a meeting at Edinburgh, which was attended by a number of foreigners. As a result of this meeting they agreed to the following resolutions:—(1) That the resistance of a specified column of mercury be adopted as the practical unit of resistance; (2) That 14·4521 grammes of mercury in the form of a column of uniform cross-section, 106·3 cm. in height, at 0° C., be the specified column; (3) That standards in mercury, or solid metal having the same resistance as this column, be made and deposited as standards of resistance for industrial purposes; (4) That such standards be periodically compared with each other, and also that their values be redetermined at intervals in terms of that of a freshly set up mercury column. It was further agreed that these resolutions be communicated to the Electrical Standards Committee of the Board of Trade. It was agreed that the number 0·001118 should be adopted as the number of grammes of silver deposited per second from a neutral solution of nitrate of silver by a current of one ampere, and that the electromotive force of a Clark cell at 15°C. should be taken as 1·434 volts.

Prof. von Helmholz remarked that a column of mercury was much preferable to alloys, in which small fissures might exist or come into existence. He alluded also to the manner in which the difficulties of setting up such a mercury column, arising from the want of proper contact between the mercury and the glass, may be overcome. The British and German tests agreed so closely as to show that the results might be used for commercial purposes, possibly for centuries; though, for scientific purposes, some change might be needed. He and others had been sent here by their Government with the object of coming to an agreement on this subject with Great Britain, and it was hoped that America and France would also adopt the resolutions.

Wire Standards of Electric Resistance, by Dr. Lindeck, of Berlin.—The author described experiments on this subject. Alloys containing manganese seem to be the best for the purpose. Those containing zinc are the most objectionable because of impurities. Changes of resistance depending on the process of winding the coils were also investigated. The best results were got with the alloy manganin. Changes of resistance, apparently due to oxidation from contact with the air, take place; but these can be avoided by varnishing the wire. The resistance rises slowly with temperature, reaches a maximum, and then decreases rapidly.

Prof. Sylvanus Thomson said that, in working with manganin, he had found that it could not be relied upon if too strong a current were sent through it. He agreed that no alloy containing zinc should be used.

On the Clark Cell, by Dr. Kahle, Berlin.—Dr. Kahle gave details of experiments made on Clark cells. He found that they furnished a very trustworthy standard of electromotive force, and that they were very suitable for practical work.

Prof. Carhart said that he had found cells, made by different persons at different times, gave practically the same result when used under the same conditions.

Mr. Glazebrook said that he had come to the conclusion that differences amongst the results given by different cells were due to the fact that the time taken to reach the equilibrium condition differed in different cells.

Preliminary Account of Oceanic Circulation, based on the Challenger Observations, by Dr. A. Buchan.—In communicating this account, Dr. Buchan remarked that the enquiry had so far advanced that the chief results could be stated. The *Challenger* observations have been supplemented by those of Mohn, Agassiz, J. T. Buchanan, Belknapp, and Capt. Wharton. The surface winds of the globe have a special bearing on the subject of ocean temperature. The surface winds of the Atlantic generate currents which have the effect of raising the temperature on the west side of the Atlantic, at depths from 100 to 500 fathoms, about 10 degrees above the temperature at these depths on the east side. At 500 fathoms the temperature is nearly the same at both sides of the Atlantic, but at lower depths the effects are reversed. At these depths the west side is more under the influence of the Arctic currents along the American coast, and the east side is more under the influence of the under currents from the Mediterranean and the equatorial regions of the Atlantic. This high temperature distribution extends northwards even beyond the Wyville Thomson ridge between Shetland and Iceland. At 700 fathoms the temperature just south of this ridge is five or six degrees higher than it is over the Pacific, Indian, and

South Atlantic Oceans at that depth. At 200 fathoms the temperature of the Mediterranean is about 56°, and is practically constant down to the bottom (1500 fathoms in some places). Similar conditions hold in the Gulf of Mexico, where the temperature at 700 fathoms is $25^{\circ}\cdot 5$, with no change at lower depths. On the other hand, north of the Wyville Thomson ridge in the North Atlantic, there is a uniform temperature of about $29^{\circ}\cdot 5$ at all depths below 700 fathoms—that temperature being about two or three degrees higher than the freezing point of the water. This undercurrent of warm salt water from the Mediterranean, extending even beyond the North Cape of Norway, seems to explain why there is no instance of an iceberg appearing off the west coast of Europe.

Physical Condition of the Waters of the English Channel, by Mr. H. V. Dickson.—The constitution of the samples of water agreed, on the whole, with that of the *Challenger* samples, coinciding entirely with that of the Atlantic water. The tidal currents are sufficiently strong to keep the water thoroughly mixed from the top to the bottom, except off Start Bay, where a vortex is formed—the water being colder in summer, and warmer in winter, than the surrounding water, and this spot is one of the best fishing grounds in the Channel.

On Primary and Secondary Cells in which the Electrolyte is a Gas, by Prof. Schuster.—When an electric discharge passes through a part of the gas filling a tube, all the gas is brought into a state in which it readily conducts electricity. Prof. Schuster has studied the laws of this conduction. If we assume that the primary phenomena of discharge depend on dissociation of the molecules, he remarked that it must often have appeared peculiar to experimenters that no phenomena of polarization appear. When an elementary gas is used no such phenomena appear. When compound gases are used only slight polarization appears; but Prof. Schuster has found that the phenomena become very marked when hydrocarbons are used. The law of decrease of polarization in this case resembles that which is observed when liquid electrolytes are used. This points to the performance of work of the nature of electrolysis. The magnitude of the effect depends on the nature of the electrodes. It is small when copper and iron are used; but is very large when aluminium or magnesium are used. When a latter metal was employed, a direct current being passed for a long time, a reverse electromotive force of 35 volts was got from a single cell. This shows that the action is similar to that of a secondary cell. Prof. Reinold has already described cases in which gases act as an electrolyte in a primary circuit when under the influence of a discharge. Prof. Schuster has found that, in such cases, the employment of aluminium electrodes gives very strong effects.

On Leaky Magnetic Circuits, by Dr. du Bois.—It appears from the experiments described that the leakage decreases when the magnetization is increased.

Experiments on the Electric Resistance of Metallic Powders, by Dr. Dawson Turner.—It is well known that metallic powders have very great electric resistance. This can be reduced to an extraordinary degree by the passage of an electric spark in their neighbourhood. Amongst other substances Dr. Turner has tried powdered aluminium, copper, annealed selenium, iron filings, small shot, mixtures of aluminium and resin fused into a solid mass, etc. The best results were obtained with the first two. A short glass tube, filled with powdered aluminium, is placed in circuit with one or two cells and a galvanometer. No current passes until a spark discharge occurs in the neighbourhood, when a fairly large effect becomes visible. The powder continues to conduct for a short time unless it be shaken or disturbed, when the effect ceases. In the case of the rod of aluminium and resin, mere shaking does not destroy the effect, though the application of heat does. When the resistance has once been lowered in this way, the powder becomes very sensitive, a spark at a great distance produces the effect, and a very slight jar destroys it.

On the Stability of Periodic Motions, by Lord Kelvin.—The mathematical investigation of this subject was illustrated by an experiment in which a simple harmonic vertical motion was given to the point of support of a pendulum. When the period of the superposed motion was one half of that of the natural motion of the pendulum, the equilibrium became unstable, and the slightest disturbance caused the vertical motion of the bob to be changed into transverse motion of increasing amplitude. If the superposed period were now lessened, the vertical motion again became stable. Similarly a rod poised vertically in unstable equilibrium could become stable by having its point of support moved with simple harmonic motion, of proper period, in a vertical line.

Prof. Osborne Reynolds remarked that it was well known to practical engineers that a revolving shaft, when driven at a certain speed, began to bend, and might even break, though at higher speeds it would again become straight. Lord Kelvin had now explained this effect.

On the Specific Conductivity of Thin Films, by Profs. Reinold and Rücker.—When the film was an aqueous soap solution containing a considerable portion of glycerine and a small proportion of a metallic salt, the specific conductivity was the same, whether the liquid was in mass or was drawn out into a film not exceeding 1-200,000 in. in thickness. When the liquid consisted of an aqueous soap solution alone, the specific conductivity increased when the thickness became small, until, in the thinnest film observed, it was seven times as great as at first. The effect seemed to be due to a breaking down of equilibrium when the tenuity was extreme.

A Contribution to the Theory of the perfect Influence Machines, by J. Gray, B.Sc.—The theory of the perfect influence machine has been shown by Clerk Maxwell to be analogous to Carnot's theory of the perfect heat-engine. Maxwell points out that there is a loss of energy in the ordinary influence machine through sparking at the contacts, which would render the machine inefficient, even though losses from leakage and the like were done away with. Maxwell has described a machine in which sparking and the loss due to it is eliminated. This is done by causing the carrier of electricity always to make contact with charging and discharging conductors when the former is at the same potential as the latter. In the case of the discharging conductor, this is done by prolonging the contact springs to meet the carrier; in the case of the charging conductors this is not sufficient; it is necessary to surround the ends of their contact springs by two additional conductors charged to an equal and opposite potential, and of such capacity as will just reduce to zero the potential of the small quantity of electricity left from the previous discharge. These additional conductors were called by Maxwell regenerators, as being analogous to regenerators in the heat-engine.

The object of the author is to investigate the efficiency of an influence machine constructed according to Maxwell's design, and other designs less perfect. This is done by drawing a QV (quantity-potential) energy diagram for one revolution of the carrier. The results obtained are as follows:—

	Theoretical efficiency.
Maxwell's machine	1
,, ,, without regenerators	$\frac{Q}{Q+\frac{1}{2}av}$
,, ,, without long contacts on receivers	$\frac{2}{3}$
,, ,, without regenerators and without long contacts on chargers	$\frac{Q}{Q+\frac{1}{2}aV}$

where Q = quantity received or discharged by a carrier in each revolution,
V = the potential (numerical value) of the positive or negative receiver,
v = the potential of the residual charge to be reduced to zero by the regenerator,
a = the part of the carrier's capacity due to its not being completely surrounded by the discharging conductor.

The conclusion is that the regenerators are of much less importance than the long contacts in adding to the efficiency of an influence machine.

Experiments with a Ruhmkorff Coil, by Messrs. Magnus Maclean and A. Galt.—The quantity of electricity induced in a secondary circuit by a make in a primary circuit is equal to the quantity induced in the same secondary by a break in the primary. If, however, there is a non-metallic gap in the circuit, the *break* impulse causes a flow in one direction, and the *make* causes either no flow, or a much less flow in the opposite direction; because the short intense impulse of the former breaks down the resistance, while the comparatively long and less intense impulse of the make either does not break down the resistance at all or only does so to a slight extent, so that the effective resistance is much greater in one direction than in the other. To obtain the average difference of the quantity of electricity set in motion in one direction over that in the other, an electrolytic cell and a vacuum tube were placed in the secondary circuit of a small Ruhmkorff coil. The solution in the cell was sulphate of copper of density 1·7 with $\frac{1}{2}$ per cent. of commercial sulphuric acid added. The mean of seven experiments, lasting from two to four hours, gave the average electrolytic current, calculated from the gain of the cathode, as $\frac{1}{6}$ of a milliampere. A similar experiment, in which the vacuum tube was replaced by a very large liquid resistance, led to no result.

The Application of Interference Methods to Spectroscopic Measurement, by Prof. A. Michelson.—Prof. Michelson's "wave-compiler" consists essentially of a small plane sheet of glass with parallel surfaces and two mirrors. The mirrors are set at right angles to each other and the central plane of the glass passes through their line of intersection, making an angle of 45° with each of them. Rays of light from the source under examination fall upon the glass surface at an angle of 45°, and are partly reflected, partly transmitted, so as to suffer normal reflection at the mirrors, and finally proceed from the other surface of the glass, at an angle of 45°, to the eye. Normal displacement of one of the mirrors parallel to itself causes a difference of path which produces interference. If the source of light emits radiation of two wave-lengths (as in the case of incandescent sodium), or of more, the brightness of the interference bands—regarded from the centre outwards—exhibits periodic variation, which can be accurately observed. The law of variation can be calculated when the distribution of light in the source, as regards wave-length and intensity, is known. Conversely, the method can be used to determine the nature of this distribution. Mr. Michelson has examined various sources of light—oxygen, hydrogen, zinc, cadmium, mercury, &c.—and has found that lines which in the most powerful spectroscope appear single, are really double, triple, or even more complex. In examining hydrogen at different pressures and temperatures the results indicated that the widths of the component lines decreased as the pressure decreased, but not without limit. Investigations made on a large number of substances give strong confirmation of the kinetic theory of gases.

On a Periodic Effect which the Size of Bubbles has on their Speed of Ascent in Vertical Tubes containing Liquid, by Dr. F. T. Trouton.—The chief peculiarity observed when a bubble of air ascends in water is that the speed of ascent is a periodic function of the size of a bubble. The form of the curve obtained by plotting the volumes of the bubbles as abscissæ and the corresponding speeds as ordinates showed that at first, as would be expected, increase in size diminishes the speed; but afterwards the speed increases in value, then reaches a maximum at about twice the minimum speed; and so on two or three times, depending on the diameter of the tube employed. The oscillations in the curve die out in much the same fashion as those of a pendulum in a viscous medium. The form of the bubbles was almost spherical at the first minimum; after this the bubble is pointed at the top until the second minimum is reached, when it is again rounded at the top, but has a dumb-bell shape, and so on, presenting in this way similarities to the breaking up of a liquid column through surface tension. Liquids which do not mix with water were used instead of air; and air bubbles in other liquids were also used.

On a Method of Determining Thermal Conductivities, by Mr. C. H. Lees.—The method has more direct application to the determination of the conductivity of a liquid than previous methods have. It consists in measuring the amount of heat conducted, under given conditions, through a film of liquid placed between two copper cylinders. It was found most convenient to keep the upper cylinder at the temperature of the surrounding air, while the lower one was kept cool by water from the mains. Precautions were taken against errors from radiation, &c.

A Magnetic Curve Tracer, by Prof. Ewing.—The apparatus is designed to plot mechanically the ordinary magnetization curve. The curve is traced on a screen by a spot of light reflected from a mirror, which is subjected to two motions—one proportional to the magnetizing force, the other to the magnetization. These motions are communicated by means of the sagging of wires placed in air-gaps in magnetic circuits. In the one case, the wire carries a steady current in a varying field; in the other the wire carries the varying current in a steady field. The curves may be traced on sensitized paper; and the instrument should be of much use to engineers for testing purposes. In working with the instrument Prof. Ewing has observed true effects of magnetic time-lag in the inward penetration of magnetization.

On a Magnetic Balance, and its Practical Use, by Prof. du Bois.—A test bar of standard size is placed within a magnetizing coil. Over this is placed an iron yoke, balanced on a knife edge, and having attached to it a graduated scale with sliding weights. When a current passes through the coil the equilibrium is disturbed, and it is restored by sliding the weight along the scale. The position of the weight then gives the magnetization in absolute measures in c.g.s. units. The position of the yoke is one of unstable magnetic and mechanical equilibrium.

On Earth Current Storms in 1892, by Mr. W. H. Preece.—In communicating this paper, Mr. Preece spoke of the great importance of observers at all parts of the globe contriving to collect data regarding electric storms.

On the Dielectric of Condensers, by Mr. W. H. Preece.—The author pointed out that in the condensers used by him there was evidence of work done upon the insulating material, which necessarily retarded the rate of propagation of signals.

On Polarizing Gratings, by Prof. du Bois.—The author has constructed minute gratings with silver wire scarcely visible to the naked eye. Radiant heat and long light waves are polarized by these gratings in the same way as electromagnetic radiations are polarized by larger wire gratings.

The Volume Effects of Magnetism, by Dr. C. G. Knott.—The results for iron tubes have been already described in NATURE. In one case a steel tube, of given bore and thickness of wall, gave increase of internal volume in all fields used. Usually the volume diminishes in low fields and increases in high. The effects were shown to the audience by projection upon a screen.

An Estimate of the Rate of Propagation of Magnetization in Iron, by Prof. Fitzgerald.—Assuming that the iron is constituted of a system of little magnets, and with possible assumptions as to the size of these magnets and their strength, it is found that their natural rate of vibration may be one hundred millions per second. Unless the period of the vibration propagated through the iron approximates to this the wave lengths would be very small; while quicker vibrations, with periods like those of light, would not be propagated at all.

Experimental Proof that the Coefficient of Absorption is not affected by Density of Illumination, by Dr. W. Peddie.—When parallel rays of light pass through a uniform absorbing medium, the intensity of the light diminishes according to a certain law. The assumption which, on this point, is made the basis of the theory of radiation is that the fractional dimunition of intensity, at any stage, per unit of thickness traversed (called the coefficient of absorption), is independent of the intensity of the light. Sir G. Stokes has indicated a method of testing the point by the reflection of light, at nearly perpendicular incidence, from the surface of glass—part of the absorbing medium being placed in the path of half of the light before reflection, and a similar part being placed in the path of the other half after reflection. Both portions, being then projected on a screen, could be directly compared in respect of colour and intensity. No test seems to have been made by this or any other method. In Dr. Peddie's method light is passed through two double image prisms and a plate of quartz. Four rays are thus produced, coloured alike in pairs, the colour of one pair being complementary to that of the other. The colour of one pair can be made to match as nearly as possible the colour most readily absorbed by the medium, similar portions of which are placed at different distances from the points from which these rays are made to diverge by means of a lens. The light being projected on a screen, a direct comparison is obtained. The media used were pieces of surface-coloured glass. In no case was any difference observed, although the intensity varied from 1 to 1000, and the eye could have observed the difference of one per cent. in the brightness of the two discs thrown on the screen, without the additional help of change of colour.

On Dispersion in Double Refraction due to Electric Stress, by Dr. John Kerr.—The fact of dispersion has been established, and it is found that the optical effect depends upon the wave-length, being the inverse ratio of the square root of the wave-length.

On a Delicate Calorimeter, by Messrs. J. A. Harker and P. J. Hartog. This is essentially a Bunsen ice-calorimeter, with solid acetic acid instead of ice, so being much more delicate, and capable of being used at ordinary temperatures.

On Graphic Solutions of Dynamical Problems, by Lord Kelvin.—The method of drawing meridional curves of capillary surfaces of revolution, described in "Popular Lectures and Addresses," vol. i., 2nd edition, pp. 31-42, suggests a corresponding method for the solution of dynamical problems.

Reduction of every problem of Two Freedoms in Conservative Dynamics, to the drawing of Geodetic Lines on a Surface of given Specific Curvature, by Lord Kelvin.

1. Any conservative case of two-freedom motion is proved to be reducible to a corresponding case of the motion of a material point in a plane.

2. In plane conservative dynamics, with any given value for the energy-constant, E, the resultant velocity, q, at any point (x, y) is a known function of (x, y), being given by the equation

$$q^2 = 2(E - V) \quad . \quad . \quad . \quad . \quad (1)$$

where V denotes the potential at (x, y); and every problem depends on drawing lines for which $\int q\,ds$ (the Maupertius "action") is a minimum.

3. Considering any part, S, of the infinite plane, find a surface, S', such that any infinitesimal triangle $A'B'C'$ drawn on it has its sides q/q_0 of those of a corresponding triangle ABC in the field, S, of our plane problem; q_0 denoting the value of q at any particular point (x_0, y_0) in the plane. By the principle of least action we see instantly that the lines on S' corresponding to paths on S, are geodetic. Thus the *adynamic* case of motion of a particle on S', is found as a perfect and complete representative of the motion on the plane surface S, under force with any arbitrarily given function V, for its potential, and any particular given value, E, for the total energy of the moving particle.

4. It is easily proved that the surface S', to be found according to §3, exists; and that its specific curvature (Gauss's name for the product of its two principal curvatures) at any point; is equal to

$$\frac{q^2{}_0\,\Delta^2 \log q.}{q^2}$$

5. Examples are given of the finding of S'. As one example, illustrating the practical usefulness of this method in dynamics, the problem of the parabolic motion of an unresisted projectile is reduced to the drawing of geodetic lines on a certain figure of revolution of which the explicit equation is expressed in terms of elliptic functions.

THE PERIODIC VARIATIONS OF ALPINE GLACIERS.

THIS twelfth Report, dealing with the Alpine glaciers and their changes, by Dr. Forel, comes in the nick of time, and will be generally welcomed, for it announces that the question of glacier-changes in the Alps will in future be studied systematically; and, further, we learn in a postscript that the State Council of the Canton of Le Valais have, on the proposition of M. Maurice de la Pierre, head of the Home Department, decided to take under its efficient direction the studies of observation and control of the variations of glaciers. These observations are confided to the charge of the Cantonal Administration of Forests, the head of which is M. Antoine de Torrenté at Sion. M. Forel records this act of intelligent and prudent administration with keen satisfaction and true gratitude, and would gladly see it imitated by other cantons possessing glaciers. M. Forel publishes also the report, which, in compliance with the wishes of M. de la Pierre, he had addressed to the Home Department of Le Valais. It is equally applicable to the glaciers of other cantons in Switzerland, and we therefore print it *in extenso*.

M. de la Pierre, Councillor of State, head of the Home Department, Sion.

SIR,—Referring to the interview you granted me on January 31, and in reply to your question, I have the honour to give you the following particulars:—

Glaciers in general, and particularly those of Le Valais, are subject to variations in shape, which, according to an irregular periodicity, cause them sometimes to grow in length, in breadth, in thickness, sometimes to decrease, often in very considerable proportions. These variations, which in recent centuries have attracted the attention of the populations interested and of naturalists, have in this century been the subject of direct study, especially during the last twenty years.

It has been recognized that most of the great catastrophes which have ravaged the region of the high Alps, have been caused by these glacial variations. It is when the glacier extends, lengthens, arrives at its maximum, that it not only invades the fields and destroys Alpine chalets, but barricades the valleys, arrests the flow of rivers, and creates temporary lakes, the evacuation of which ravages the country; or else, surpassing its usual dimensions, it forms an avalanche, the destructive power of which is terrible. Taking my examples from Le Valais, I attribute to forces of this kind: the catastrophes of the Valley of Saas, 1633, 1680, 1772, caused by the overflow of the lake Mattmarck, due to the stoppage of the Viège by the glacier of Allalin; the catastrophes of the valley of Bagne, 1545, 1605, 1818, caused by the formation of a temporary lake behind the barricades of the glacier of Giétroz; the catastrophes of Randa, 1636, 1819, caused by the fall of the glacier of Bies, which had assumed extraordinary dimensions; perhaps we might also attribute to the same source the inundations of St. Bartholomew, 1560, 1635, 1636, 1835, which may have been due to the excessive increase and fall of the terminal extremity of the glacier of Plan-névé of La Dent-du-Midi.

Since these variations of glaciers are the cause of great catastrophes in mountainous regions, they are deserving of attentive study; there is scope to form theories and to recognize the rhythm of their periodicity; it is very necessary to be able to foresee their development, in order to ward off threatening events.

Now, the preparatory study which we have made within the last few years has shown us that the periodicity of glacial variations is much longer than was formerly believed to be the case; the popular dictum that the increase in the size of glaciers recurs every seven years is certainly incorrect. We cannot yet give definite figures, but probably the cycle of glacial variation is as much as 35 to 50 years. The latter period alone has been studied attentively; if 1850 or 1855 be fixed upon as the epoch of maximum of glaciers, they have been steadily decreasing in past years, so that from 1870 to 1875 we were not aware of a single one on the increase. In 1875 the Glacier des Bossons du Mont Blanc gave the signal for a new period by commencing to lengthen out; it was followed in 1878 and 1879 by the glaciers of Trient and Zigiorenove, then successively by some thirty glaciers in different valleys of Le Valais; but the phase of increase is not yet general in your canton; a number of large glaciers, Arolla, Otemma, Corbassière, Le Gorner, Le Rhone, are still decreasing or stationary. It is only of the Mont Blanc group that the increase can be said to be general; in Le Valais it is in process of development, and we are still very far from the maximum stage of glaciers. If, as is probable, the maximum only arrives at the commencement of next century, the actual period of glaciers will have lasted more than fifty years.

Thus this is a phenomenon, whose cycle is equal or superior to that of the average human life; one generation of men witnesses only one of the glacial variations. It is a phenomenon of such majestic slowness that its study is exceptionally difficult.

A phenomenon of which a man can, in his whole life, see but one manifestation, surpasses in its amplitude the powers of initiative individual study. To observe the facts of so prolonged a period, organizations are required of a superior duration. Shall we address ourselves, therefore, to learned societies, which, being continually renewed, may be supposed to have sufficient continuance? We fear that, even in the most powerful of these societies, Societies of Naturalists and the Alpine Clubs, a sufficiently keen interest in observations, which can only be utilized after the lapse of some generations will not be felt for the observations to be organized and carried out with the necessary perseverance. It seems to us that the State alone, by virtue of the indefinite continuance it enjoys, is in a position to follow out this study with a sufficiently long grasp. However much we may be in favour of private individual or collective initiative action in researches and scientific work, in this special case we believe it advisable to have recourse to the State administration, considering it the only institution of sufficient duration to proceed to the study of phenomena of such extreme slowness.

We therefore take the liberty of addressing ourselves very respectfully to the Government of the Canton of Le Valais, and begging it to introduce the study and observation of the variations of glaciers, which have so great an influence on the prosperity of mountain populations.

It seems to us that the State department best fitted for such a study would be that of the Administration of Forests. The forest inspectors and their agents are called upon by their functions to travel over the high valleys of the Alps; they would thus be able, without great additional labour, to undertake the observation of glaciers.

As to the programme on which they should work, we would simplify it as much as possible, and reduce it to two points:—

1. To attentively survey the glaciers in order to fix for each one the year of maximum and the year of minimum extent in their successive variations.

2. To specially watch the dangerous glaciers, and warn the Administration of the danger they may cause by assuming exaggerated dimensions during their phase of development.

In order to carry out this double programme, the Government should charge each inspector of forests to study the glaciers of his district, and to inscribe on a register *ad hoc* the state of growth and decline of each glacier every year. For important glaciers, interesting or dangerous, he should have measurements made from fixed marks, and state in exact figures the changes in the dimensions of the glaciers; for little, uninteresting, or unimportant glaciers, occasional inspection and the reports of the mountaineers would suffice to ascertain their state of growth or decrease.

M. Antoine de Torrent, Inspector-General of the Forests of Le Valais, has long been occupied in collecting observations on the glacial variations of our Alps; it is from him that we have obtained all the facts recorded by science in this field of research in Le Valais; it is for him, not for us, to give instructions as to the way in which the observations should be organized.

This study is not an expensive one; it calls for no great outlay on the part of the State, nor does it make great demands on the powers and the time of the observers. It may lead to important and useful results. It can only be successfully carried out by the State, since that alone has the necessary persistence to continue it long enough. I therefore venture to recommend these studies on the variation of glaciers to your great benevolence, and to the enlightened solicitude with which you follow all questions interesting to the public welfare. Men of science, who consecrate their lives to the study of the phenomena of nature, are ready to help you to the best of their ability to study these questions from a theoretic point of view. But it is necessary, in order to arrive at practical results, to have a collection of materials of observation which the State alone seems to us capable of bringing together with success.

Accept, M. le Conseilleur de Etat, the expression of my very respectful and devoted consideration.

F. A. FOREL.

Morges, February 10, 1892.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 8.—M. de Lacaze-Duthiers in the chair.—The "Pythonomorphs of France," by M. Albert Gaudry. Announcing the discovery of the snout of one of the great chalk reptiles termed pythonomorphs by M. Cope, on account of their similarity to the sea serpent as imagined by the ancients. The specimen is from a pythonomorph 10m. long, and was found in the upper chalk of Cardesse, near Pau. It is similar to the *Mosasaurus giganteus* of Maestricht, and has been termed *Liodon mosasauroides*. A smaller and somewhat similar specimen was also found, and was termed *Liodon compressidens*. These and a few minor fragments are the first representatives of the pythonomorphs found in France.—On the production of sugar in the blood at the expense of the peptones, by M. R. Lépine.—On the lava of July 12, 1892, in the torrents of Bionnasay and Bon-Nant (catastrophe of Saint-Gervais, Haute Savoie), by M. P. Demontzey. After describing the probable course of the catastrophe, the writer comes to the following general conclusion:—That the lava of July 12 has behaved exactly like those which have been observed before in the torrents of the Alps and the Pyrenees. That its energy was all the more disastrous as the transport in masses commenced in the most elevated regions of the torrent basin after the sudden bursting forth of a large body of water concentrated more rapidly even than in the most violent hailstorms in the upper basins of torrents without glaciers. That the volume of the deposited materials of all sorts—estimated at about one million cubic metres—presents no anomaly in comparison with the relatively small amount of water, which effected the transport by a series of successive bounds, with alternate momentary accelerations and retardations of speed. That this torrent phenomenon has substituted for a simple and hitherto harmless rivulet a torrent whose activity can be mastered with a relatively short delay. That both in the Alps and the Pyrenees similar cases of the transformation of peaceful rivulets into formidable torrents can be cited, aggravated by the fact of their being caused by rain, which is even more difficult to predict and ward off than the dangers presented by a glacier. And lastly, that this great disaster could not have been provided against, since nobody had had the idea even of exploring the glacier of Tête-Rousse.—On a property of lamellar bimetallic conductors submitted to electromagnetic induction, by MM. Ch. Reignier and Gabriel Parrot. An arrangement recalling Faraday's disc is obtained by substituting for the ordinary copper conductors thin plates composed, along their thickness, of a very magnetic and a highly conducting metal, so placed that the lines of force are perpendicular to their thickness. The flow of induction emanating from the north pole is divided into several sheets of parallel lines very close together, which only traverse the magnetic portions of the bimetallic conductors, and the tubes of force become cylindrical. The available energy in such an arrangement increases at a rate which is sensibly proportioned to the height of the conductors. An apparatus constructed on this principle gave, with a weight of 750 kg. and a velocity of 500 revolutions, 32,000 watts giving an output of 42 watts per kg. of the machine.—The application of the measurement of density to the determination of the atomic weight of oxygen, by M. A. Leduc. The composition of water by volume, and thence its composition by weight, were determined by finding the density of a mixture of hydrogen and oxygen produced by the electrolysis of an alkaline solution. After an electrolysis of several days, during which the superfluous gas was allowed to escape through mercury, the liquid and the platinum poles were saturated with gas, and the density obtained by the method previously described did not vary by more than 0·0001 gr. The value within $\frac{1}{100}$ per cent. was 0·41423. The volume ratio between hydrogen and oxygen was 2·0037 at 0°, and the atomic volume of oxygen 1·9963. The atomic weight of oxygen by this method is 15·877, and by the synthetic method 15·882, so that 15·88 must be taken for the mean atomic weight. Hence the molecular weight of water vapour is 17·88, and its theoretical density 0·622.—On the general form of boiling-point curves for central substitution compounds, by M. G. Hinrichs.—Note on the existence in the earth of an acid mineral substance as yet undetermined, by M. Paul de Mondesir. If all the carbonic acid contained in lime be driven off by a strong acid, and the ratio of lime to carbonic acid be carefully measured, the lime is found to exceed the quantity necessary for saturation. The earth remains always acid and capable of decomposing carbonate of lime in the cold. That this acid residuum cannot be humic acid or free silica is proved by the total destruction of the organic substances by ignition or potassium permanganate, which leaves the property in question unaffected. The quantity of acid matter varies from ·2 to 1 per cent. of the earth. It is very stable, and its composition has not yet been determined.—Calcareous soap and boiler explosions, by M. A. Vivien.—Pupine, a new animal substance, by M. A. B. Griffiths. This is extracted from the skin of the chrysalis of several lepidoptera.—On the colouring matter of *Micrococcus prodigiosus*, by the same.—On the coccoid state of a nostoc, by M. C. Sauvageau.—On an alga living in the roots of the *Cycadeæ*, by M. P. Hariot.—On the presence of fossils in the azoic formations of Bretagne, by M. Charles Barrois.—On the discovery of cut flints in the quaternary *Rhinoceros Mercki* alluvium of the Saône valley at Villefranche, by M. Ch. Depéret.

ROME.

R. Accademia dei Lincei, June 5.—The 289th annual meeting, honoured by the presence of H. M. King Umberto I.—The President introduced the two committees charged with the examination of the works in competition for the two royal prizes of 10,000 lire each, one for social and economic sciences, the other for mathematical sciences. Senator Lampertico, reporting for the first committee, said that, although two essays, one on "Ancient Socialism," by Salvatore Cognetti de Martiis, and another on the laws of the distribution of wealth, bearing the motto, "Laboremus," had shown considerable merit, the committee had not felt justified in awarding the prize to either.

Professor Cerruti, on behalf of the second committee, reported that two candidates had been found equally deserving of the mathematical prize, viz., Professor Luigi Bianchi by his essays on the triple orthogonal systems of Weingarten and allied subjects, and Professor Salvatore Pincherle in virtue of his various works on the general theory of functions. It was therefore decided to divide the prize equally among these two candidates. —The last of the ministerial prizes for professors of secondary classical and technical schools, amounting to a total of 9000 lire for philological, and 9000 lire for physical and chemical subjects, were distributed among thirteen candidates, prizes of 3000 lire being obtained by Professors Nasini and Costa for their work "On the Variation of Refractive and Dispersive Power of Sulphur in its Compounds," and by Dr. Enrico Salvioni for his contribution "On the Construction of the Legal Ohm."—General Ferrero then addressed the meeting on the subject of scientific measuring instruments. Although, he said, the human eye, that natural model of the telescope, the microscope, and the photographic camera, can distinguish within a few hundredths of a millimetre whether two points are in contact; although the ear can appreciate sounds ranging from 32 to 70,000 vibrations per second, and is able, while following the rhythm of a full orchestra, to discover the slightest dissonance; yet the power of our senses is limited to a comparatively small portion of the infinite variety of external phenomena, that portion which is of more immediate value for our merely animal life. The errors which the unaided senses are liable to lead us into are mainly due to their subjectivity, which renders the impressions of one individual incomparable with those of another, or with his own under different conditions. The use of instruments enables us to submit these impressions to measurement, to compare them amongst themselves, and immensely to extend our field of investigation towards the infinitely great and the infinitely small. The progress made in this direction during the last few hundred years justifies the hope that the time is not far distant when the results of observation will be as far as possible beyond the personal influence of the observer. The disciple of science will read the truth in the book of nature, traced out by the phenomena themselves. The universe, which has always remained inaccessible to metaphysics, will willingly disclose its secrets to the researches of modern science. This owes its great progress during the last century mainly to the perfection and delicacy of its measuring instruments, which has made modern astronomical observations a thousand times more accurate than those of the Chaldees, and has, by making very minute differences of temperature appreciable and measurable, enabled biology to enter the ranks of the exact sciences. The accuracy of measurements of length and mass is ensured by the arrangements in connection with the International Office of Weights and Measures at Bréteuil. Some recent comparisons of standards gave a probable error in length of 1/20,000mm., while that for mass was 4/1000 mgr. The determination of weight has been carried to such a pitch of accuracy, that it has been found possible, at Bréteuil, at Monaco, and at Rome, to measure the slight differences of weight produced by varying the height above the ground by a few metres. For the measurement of time there has been no necessity of fixing a conventional standard. The marvellous invention of the pendulum has made it possible to subdivide almost indefinitely the natural fundamental unit, the duration of the rotation of the earth. In the determination of longitudes the error has been reduced to one or two hundredths of a second. Hipp's chronoscope, which may be called a microscope for time, enables the observer to subdivide time to a thousandth of a second. The impulse given to biological research by such instruments has been astonishing. The time of reaction to the various sensory stimuli has been fixed at 136 thousandths of a second for sound, at 150 for light, 133 for touch, 359 for taste, and 443 for smell, while the velocity of propagation of a nervous impulse has shown itself to be 37m. per second. In artillery, the chronoscope has been utilized for the study of the initial velocities of projectiles, and for the tracing of diagrams expressing the relations between spaces, times, and explosive pressures. Errors of observation may be due to the imperfection of the senses, to unavoidable faults in the construction of the instruments, and to external influences. These may be classified according as they are constant or accidental, or better as periodical or otherwise. Most of the errors due to the observer, and of those due to external influences, are periodical, and may be eliminated by repeating the observations under varying conditions. The calculus of probabilities shows that the precision of results, so far as the elimination of purely accidental errors is concerned, increases with the square root of the number of observations. But experience shows that beyond a certain number of observations the increase of precision is illusory. This is probably due to the existence of other errors of a constant character which escape analysis, and from which it is not possible to protect the observations. Experiment also proves that for all kinds of work the maximum error does not exceed a certain limit, which is a function of the mean error. For angular measurements, this does not exceed three times the mean error, so that according to Gauss's law of errors it would be safe to lay 1000 to 1 against the chance of an error greater than 3·2 times the mean error. The observer himself must above all have physical qualities enabling him to use his senses under the best possible conditions. In addition to well-trained senses and facility in managing his instrument, he must have a clear mind, a correct judgment, and a sound scientific preparation for the research he undertakes. Concentrated upon his research, he must abstract himself from the surroundings among which he lives, and possess a spirit unimpassioned enough to subject himself to a purely objective criticism. In concluding, the speaker pointed out that there is at present no science which treats of measurement in general, as a preparation to all the sciences which aim at quantitative results. Many treatises on astronomy, on geodesy, on physics are prefaced by theories of instruments and the compensation of errors. But even those works which profess to treat of the art of measuring are usually limited to geodetic and topographic measurements. It is to be hoped that this important vacancy may soon be filled up, and that a *Science of Measurement* will unite the elements dispersed among the various sciences in one compact and harmonious whole.

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THURSDAY, AUGUST 25, 1892.

BRAMWELL'S CLINICAL ATLAS.

Atlas of Clinical Medicine. By Byrom Bramwell, M.D. Vol. I. (Edinburgh: Constable, 1892.)

THIS large and handsome volume is highly creditable to the author and to the Extramural School of Edinburgh, in which he is a lecturer. It consists of a series of thirty admirably coloured plates, mostly portraits of patients, with about an equal number of woodcuts, and descriptive letterpress. The account of the several diseases illustrated is so full and good that it almost makes the work a collection of illustrated monographs.

The diseases described and portrayed in this first volume are myxœdema and sporadic cretinism, Addison's disease, Hodgkin's disease, unilateral atrophy of the face, bulbar paralysis, Ophthalmoplegia externa, Molluscum fibrosum, Kaposi's disease, variola, melancholia, and mania.

There are also reports of cases of Friedreich's disease and of a few other rare morbid conditions.

The plan adopted by the author is to give a detailed account of the case or cases illustrated, and then a discussion of the disease under the heads of anatomy, diagnosis, and treatment, concluding with minute hints (such as one would give to intelligent ward-clerks) as to the points of clinical investigation. No order is observed in the sequence of subjects, and as the work is without a preface (though not, we are glad to say, without an index), it is not clear whether the author has formed any other plan than publishing interesting cases as they may come under his notice. The words "Volume I." on the title-page encourage the hope that Dr. Bramwell contemplates an additional series, and in that case it might be desirable to arrange the completed work in alphabetical or some other convenient order.

To take the first subject treated—Myxœdema—as a specimen.

There is first a brief notice of the first patient whose portrait is given; then an account of the original description of this remarkable disease by Sir William Gull in 1873; next a discussion of its geographical distribution and incidence on sex and age; the symptoms and pathology follow, and the author agrees with the conclusion of most who have studied the question, that this peculiar condition is in some way dependent on atrophy of the thyroid body; finally, the treatment is discussed, and the method of transplantation or grafting of a portion of the healthy thyroid of an animal into the patient's body is mentioned, with the results so far obtained by Bircher and Kocher.

Three portraits of patients afflicted with myxœdema follow, each with a full clinical history of the case. They are all three excellent, the colouring as well as the design being as good as chromo-lithography can produce.

This monograph is followed by one on sporadic cretinism, which Dr. Bramwell regards as "infantile myxœdema," another way of stating the true relation which Gull's remarkable insight led him to detect when he called the disease he discovered "a cretinoid condition in the adult." The paper is illustrated by seven uncoloured lithographs.

The two plates which belong to Addison's disease are the most artistic in the book; the difficulties are, of course, much less than in the case of myxœdema. Some of the other portraits are reproductions of photographs, very good in their way, but with the defects inseparable from this mode of illustration.

The three coloured plates of the singular affection described by Kaposi under the ill-chosen title of xeroderma pigmentosum are again excellent, particularly No. xviii. The illustrations of mental disease, although they display considerable power in draughtsmanship, are perhaps open to the objection of showing such fully developed and extreme aspects of the several states delineated, that they do not much help the recognition of less marked and typical examples.

We should, indeed, advise Dr. Bramwell, if, as we hope, he is encouraged to continue this valuable series of plates, to choose for illustration rather such infrequent morbid conditions as the diseases associated with the names of Graves, Addison, Raynaud, and Friedreich than the more familiar maladies which can be always studied at first hand.

It would also be well, perhaps, if in a scientific work of importance like this the catechetical method of instruction were omitted, which here and there interrupts the course of a paper. For instance, the following conversation, though no doubt an excellent paradigm of one method of class teaching, seems out of place where it stands (p. 30).

> *Dr. B.* (to the students). The case, gentlemen, is exactly what I suspected. It is, in fact, an absolutely typical example of the disease. . . . Such are the leading facts; I shall now be glad to hear any suggestions you may have to make as to the diagnosis.
> *A Student.* Tumour of the cerebellum.
> *Dr. B.* No, it is not a case of tumour of the cerebellum.

And so on.

Here and there an inelegant word or sentence strikes the eye. Thus Dr. Bramwell pertinently remarks that Addison's discovery was not merely "a happy hit," but spoils the phrase by adding "it was no mere fluke." A more important error of omission is, that in quoting the interesting quotation which follows from Addison's original work, Dr. Bramwell makes no clear distinction between the graphic and marvellously accurate account of idiopathic Anæmia, and the description of Melasma suprarenale, as the discoverer named it, which begins: "It was while seeking in vain to throw some additional light upon this form of anæmia that I stumbled upon the curious facts which it is my more immediate object to make known to the profession." The fact is that Addison, in a few pages, made known the existence and clinical features of *two* rare and remarkable diseases—idiopathic (since called grave or pernicious) anæmia and Melasma suprarenale (since called Morbus Addisonii). Dr. Bramwell is well aware of these facts, but it would have been useful if he had fully stated them, particularly as so much confusion on the subject still prevails both in this country and in Germany.

In conclusion, we must repeat that the present volume is most creditable to the author, to his artist, and to the publishers. It is remarkably moderate in price, and we trust that it will be so well supported by societies and private purchasers that Dr. Bramwell will be encouraged to continue so admirable an enterprise.

MODERN DEVELOPMENTS IN NORWAY.

Handbook for Travellers in Norway. Eighth Edition, Revised. (London: Murray, 1892.)

NORWAY now shares with Switzerland the privilege of being "the playground of Europe," and would even take precedence were it not for the sea voyage there and back. The recent progress of tourist invasion is curiously displayed by reference to the various editions of Murray's Handbooks.

We have before us the tattered remnants of our old travelling companion and oracle—Part I of the "Handbook for Northern Europe," including Denmark, Norway, and Sweden (1849). We are there told that by the last census in 1835 the population of Christiania was 33,000. The last edition tells us that its population is now 156,000. This is good progress for a capital city, but that of the chief town of Arctic Norway is still more remarkable. Tromsö (lat. 69° 38′ N.) had in 1816 only 300 inhabitants. Its present population is above 5,700, in spite of the fact that for more than two months the sun is continuously below the horizon. On the 22nd January, when it makes its first appearance over a crag to the south of the town, there is much jubilation, general holiday, and gun firing. In the old handbook the journey from Tromsö to the North Cape is described as an adventurous expedition demanding special preparations, which are described, and ladies are warned not to attempt it. Now it is as easy as a trip from London Bridge to Ramsgate, in steam packets incomparably superior to those which carry passengers down the Thames.

In the old handbook the Skjeggedalsfos, justly described in the present edition as "more grand and picturesque than any other waterfall in Europe," is unnoticed, as also in the next edition (1858). It was then unknown to the outer world, including Norway itself, until a solitary English pedestrian—the writer—ventured to explore the valley of the Tyssedal, to climb further on, and sojourn for a night in the Ringedal. It was first described in 1859 in "Through Norway with a Knapsack." Now it is one of the primary "lions" of Norway; there is a regular passenger boat on the lake, so solitary and desolate before 1859, professional guides, and an hotel in course of erection. The other grand region of Norway—the wildest of all—the *Jotunhjem*, which in the early editions of the Handbook was merely referred to in a single paragraph of a few lines, and in 1874 in two paragraphs bracketed as a side route, was made the subject of a special section of fifteen pages in the edition of 1880, illustrated by a special map of the district. This is continued in the present edition.

The Norwegian Tourist Club has strong claims upon the gratitude of all Norwegian tourists. Besides publishing in its transactions the record of explorations which have opened up many interesting districts, it has erected huts for refuge in the Jotunhjem, rendered a visit to the foot of the Vöringfos and many similar places possible, and set up many useful sign-boards indicating paths to waterfalls, points of view, &c. The assistance thus freely given to tourists in Norway contrasts very remarkably with the twopenny tricks of British landlords, who, for a consideration, permit their tenants to put up gates and charge admission to so many of our little dribbles designated waterfalls, and other natural objects of interest.

The present Handbook is brought up to date, and improved in many respects, notably by being printed on thinner paper than heretofore, and by setting the bye routes in smaller type, as Baedekker does. There is a valuable feature altogether new, viz., a Guide to Cycling Routes in Norway. The old accounts of the old hilly roads—which are now greatly improved or wholly superseded—led to false impressions on the subject. The writer delivered a lecture on "Cycling in Norway" to the Society of Cyclists some years ago which corrected these impressions, and induced many cyclists to do Norway; this appendix to Murray's Handbook will doubtless have still greater effect. In one important respect Norway offers the cyclist unrivalled advantages, viz., its admirable national organization of "Stations" for bed and board at regular intervals of about eight miles apart, and the annual publication of an authorized guide to all the roads and all the stations thereon, of which Mr. Bennett publishes an English translation with additions and maps, which render it a very valuable handbook.

An ideal handbook of Norway is, however, still demanded. The country being a narrow strip extending from 58° to 72° of latitude, it lends itself to a scheme of simple mapping, in horizontal strips of one degree each, which would require no cross folding. Each degree on the scale of Munck's map would occupy only the depth of one of Murray's pages. The scale of this map is sufficient for pedestrians, cyclists, and carriole tourists. With such a series of maps and a small key map, the only handbook reference demanded would be designation of latitude. In 1880 the writer constructed such a series from Munck, and suggested its adoption by the publishers, but the suggestion was not carried out. The development, or rather creation, of hotels in Norway is marvellous. The night before last we stopped at the Stalheim Hotel, dined in a magnificent salon, with roomy seats for 300 guests; music at dinner; concert in capacious smoking-room every evening; several drawing-rooms and 200 beds; all the salons lighted by electricity. Formerly—at the time of our first visit—the only provision here for travellers was a very inferior "station," a little hut with two or three questionable beds; no such luxury as white bread. Much of this is due to the modern development of cruising in what may be called cooperative yachts, such as the *Ceylon* and the larger vessels of the Orient Company and others, which carry about a hundred passengers on each cruise, visit the finest fjords, and halt for inland trips, thus rendering a short holiday available for Norway, so far as the outer fringe of its grand scenery is concerned. W. M. W.

Odde, August 13, 1892.

OUR BOOK SHELF.

Ostwald's Klassiker der Exacten Wissenschaften. (Leipzig: Verlag von Wilhelm Engelmann.)

IT is extremely important that every student of science should as far as possible make himself familiar with the history of discovery in the various subjects in which he is interested. He can hope to understand thoroughly the present position of any department of science only if he understands the stages of development through which it has passed. And by far the most effective way in which this knowledge can be attained is by the study of the memoirs in which the great masters of research have recorded their discoveries and described the methods by which their results have been reached. These documents bring the student into contact with the finest intellects which have been devoted to original inquiry; and he will be surprised to find how much freshness is often given to an old doctrine when it is apprehended precisely in the way in which it presented itself to the investigator by whom it was first brought to light. Judged from the point of view of later thinkers, the achievements of even the most illustrious workers belonging to past times may be in some ways found wanting; but the mistakes of great men, when properly understood, may sometimes be almost as instructive as those of their conclusions which have stood the test of the closest and most prolonged examination.

Important as it is that the classics of science should be widely and carefully studied, they have hitherto, unfortunately, been accessible only to a comparatively small class. It was therefore an excellent idea to issue a series of them in a convenient form and at a moderate price, so that they might be brought within easy reach of all to whom the study of science is either a duty or a source of interest and pleasure. Upon the whole, those who planned the present series may be congratulated upon the manner in which their scheme is being executed. Dr. W. Ostwald is acting as general editor, while particular departments have been entrusted to specialists—astronomy to Dr. Bruns, mathematics to Dr. Wangerin, crystallography to Dr. Groth, physiology to Dr. G. Bunge, the physiology of plants to Dr. W. Pfeffer, physics to Dr. A. von Oettingen. The only serious fault we have to find is that memoirs in foreign languages have not been printed in their original form, but have been translated into German. This cannot but diminish the usefulness of the series from an international or cosmopolitan point of view; and we may doubt whether it is really the best plan even for German students. So far, at least, as English and French memoirs are concerned, there are probably few serious students in Germany who would not have preferred to have before them the actual words used by the authors themselves.

The memoirs are not being issued in chronological order. The series opens with Helmholtz's paper on the conservation of energy (1847). This is followed by papers by Gauss, Dalton, Wollaston, Gay-Lussac, Galileo, Kant, T. de Saussure, Laplace, Huyghens, Woehler, Liebig, Bunsen, Pasteur, and many other famous men of scientific light and leading.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Aurora Borealis.

THE auroral display of Friday, the 12th inst., referred to in last week's issue of NATURE, would seem to have been visible over a wide area. Between 9.30 and 10 p.m. I observed it at Boppard, on the Rhine, a few miles above Coblence. The streamers were clearly defined, but presented no unusual features, being merely rays of whitish light which slowly dissolved as the moon rose above the crest of the range of hills running along the right bank of the river. On the previous evening I was at Strassburg where, owing, I suppose, to the gas and electric lights, I took the greyish appearance of the northern horizon to be nothing more than the usual light in that quarter at this season. Further south, in Switzerland and Austria, auroræ were seen on both nights. As to "the unusual time of year for such a display," I may mention that on Sunday, August 2, 1891, I witnessed a brilliant aurora from the Deck of the R.M.S. *Teutonic*, in latitude 48½° N., longitude 30° W. It varied considerably in intensity, and continued to do so for half an hour up to 10 p.m.

HY. HARRIES.

Bayswater, August 20.

An Unusual Sunset.

THIS evening (July 29th) we were treated to a sunset of rare type, one which is unique at least in the experience of the writer.

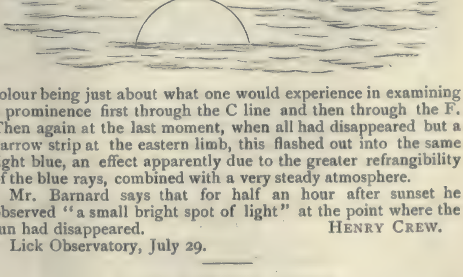
The fog was apparently *forming* round about the outer range of the mountains which lies between Mount Hamilton and the coast of the Pacific. Ordinarily, about this time of day, one can see the fog drifting over the tops of these mountains, and pouring into the valley on this side.

To-day, however, the crest of this range was barely visible above a sea of fog, which was unusually level and flat, as seen from above. Just over and along the crest was stretched a slender, thin, cloud which obscured the lower half of the sun's disc. Suddenly there formed underneath this semi-disc another of the same shape and size, and similarly placed, but not quite so bright as the true solar disc.

The accompanying figure shows essentially what was seen. The lower image I take to be that of the lower limb of the sun, shining down (from behind the upper strip of cloud) upon this quiet lake of fog and there reflected. But this amount of reflecting power in a fog if that be the true explanation, is very surprising, the image formed being not only bright and sharp, but very free from the usual glare of what are known as "brilliant" sunsets.

Another phenomenon, certainly not frequent in this country, showed itself on the limb of the sun at the point indicated by the dotted line A.

Here twice, just before the disc disappeared, the deep red colour of the solar surface turned to a bright blue, the change in colour being just about what one would experience in examining a prominence first through the C line and then through the F. Then again at the last moment, when all had disappeared but a narrow strip at the eastern limb, this flashed out into the same light blue, an effect apparently due to the greater refrangibility of the blue rays, combined with a very steady atmosphere.



Mr. Barnard says that for half an hour after sunset he observed "a small bright spot of light" at the point where the sun had disappeared.

HENRY CREW.

Lick Observatory, July 29.

The Red Spot on Jupiter.

ON August 19, at 14h. 40m., I began observing Jupiter with my 10-inch reflector, power 252. The red spot was seen slightly east of the central meridian, and it looked decidedly fainter and less definite than during the last opposition. The spot was estimated to be precisely central at 14h. 46m., and this is 14·3 minutes in advance of the time given in Mr. Marth's ephemeris (*Monthly Notices*, May, 1892). The motion of the spot has therefore shown a considerable acceleration during recent months. Between August 2, 1891, and February 2, 1892, the mean rotation period was 9h. 55m. 42·2s, but between February 2 and August 19, 1892, it was only 9h. 55m. 39·3s. This is a difference of 3 seconds, and it clearly proves that the motion of the spot is affected by some remarkable variations. A very decided retardation set in at the end of August, 1891, and continued to operate until February, 1892, but since that time the spot has exhibited an expected celerity of movement.

A large number of interesting details are now visible on the planet, but the bright equatorial spots which were so conspicuous about twelve years ago have virtually disappeared. During my observation on August 19 I saw the third satellite projected on the southern limb of the planet as a bright spot.

Bristol, August 20. W. F. DENNING.

Numbering the Hours of the Day.

WITH reference to Dr. Mill's recent interesting article on "Time Standards of Europe," I beg leave to emphatically take exception to the remark on p. 176, that "the system of numbering the hours of the day from 0 to 24 has failed to hold the popular fancy," as I maintain that the public has had no opportunity of testing the convenience of such a reckoning. The ordinary standard used in this country being railway time, so long as *Bradshaw* is printed on the old system of numbering the hours only up to 12, it is out of the question to expect the public to adopt any other. Any number of clock-faces numbered otherwise, either at Greenwich or all over the country, would not lead people to adopt the new system; the railway tables must first be altered, and as *Bradshaw* is compiled from the tables of separate companies, probably it would be necessary to approach the numerous railway companies with a view to their considering the subject and deciding upon a common plan. They would have to discuss not only the question of printing the time-tables on the new plan, but also whether it would be necessary, as well, to alter all the clock-faces at every station. I am given to understand that one railway company (in the Isle of Wight) for some time printed its tables—if it does not still—with the afternoon hours numbered from 12 to 23; though its example, because, I presume, it was of a small and uninfluential line, was not copied by any other company.

A further difficulty in the way of the public making any change is that the highest authoritative book on time matters—the *Nautical Almanac*, compiled and published by the British Government—still reckons the hours from noon. As a civil day commencing at noon is not suggested, would not the railway authorities have a ready objection to urge, and decline to alter their time-tables while time bearing the name of the national observatory, and used in the national ephemeris, were reckoned on a different plan from that which it is suggested they should adopt?

As regards the existing mode of reckoning time, the art of the printer is sometimes called in to show at once, without having to refer to the tops of columns or the sides of pages, which half of the day is meant; thus in the Midland Railway's, and part of the North-Eastern Railway's time-tables thick and thin type show this, and in some other tables a short vertical line appears between the figures of the hours and those of the minutes.

If the lists of places (p. 176) at which the time of the national standard is kept and not kept are intended to be complete, may I ask if Jersey has yet adopted Greenwich time? It had not up to 1887, although Guernsey had done so.

Sunderland, August 1. T. W. BACKHOUSE.

Propagation of Magnetic Impulses along a Bar of Iron.

IF at one end of an iron bar an alternating current be passed through a coil, will there be a wave propagation of magnetism along the bar?

Mr. Trouton (NATURE, vol. xlv., p. 42) hoped to find an answer to this question by searching after nodes, when two coils are placed one at each end of the bar, and the same alternating current is passed through both coils, or when one coil is employed on a closed iron ring. The search was conducted by a secondary coil connected with a telephone. Mr. Trouton found some places of minimum, but ascertained that these were not the nodes sought for.

Mr. Trowbridge (*Phil. Mag.* [5] 33, p. 374, 1892) made use of his phasemeter; two secondary coils, each connected with a telephone, could slide along the ring on which two large primary coils were placed. Two mirrors on the diaphragms of the telephones permitted to study change of phase by Lissajous's figures.

From his experiments, Mr. Trowbridge infers that there was no wave-motion along the iron ring; he believes that the propagation of magnetic disturbances produced by forced oscillations on iron bars is closely analogous to the propagation of heat over these bars.

Though I agree with Mr. Trowbridge in his conclusions, it seems to me that neither the experiments of Mr. Trouton nor those of Mr. Trowbridge could give any but embroiled results.

In collaboration with Mr. N. G. van Huffel, Phil. Nat. Cand. at this University, I have made some preliminary experiments on this question. Firstly, it became obvious that care must be taken against direct induction of the primary coils on the secondary. Only when the secondary coil which was connected with the telephone was embedded in a mass of copper everywhere 2·5 cm. deep, with a narrowly closing aperture for the iron bar, these direct effects were eliminated if the distance of the secondary from the primary coil were not too small. I have found no indication that similar precautions were taken in the quoted experiments.

But secondly, the telephone proved to be not the proper instrument for conducting the research. In most cases the variation of the magnetic intensity goes too slow to be perceptible by the telephone.

At one end of an iron bar (5 meters long, 1·5 cm. diameter), a primary coil A was placed; along the bar the secondary coil B (within a mass of copper, and connected with a telephone) could slide. A magnetic impulse was given by sending a current through A. If B were near A, a single tick was heard in the telephone: if the distance between B and A were greater, nothing was perceived in the telephone. However, if the circuit composed of B and the telephone were interrupted by a tuning-fork P, a sound was heard during somewhat one second and a half of the same pitch as the tone of the tuning-fork P, every time the primary current was sent through A, or broken. The intensity of this sound diminished as the distance of B from A increased, but was still perceptible wherever B was placed on the bar.

Thereupon the primary circuit to which belongs the primary coil A was interrupted by a tuning-fork Q. If no tuning-fork were in the circuit of B and the telephone, then only when B was near A a sound was heard of the pitch of Q; at a greater distance nothing was heard in the telephone. But if now a tuning-fork P interrupted the circuit of B and the telephone, a continuous sound was heard, even at much greater distances of B from A. When the pitch of P differed slightly from that of Q, beats were perceived, also when the frequency of P was nearly half that of Q. The interpretation of these facts is so apparent, that I need not dwell upon it. But these facts illustrate the principle on which Van Rysselberghe based his method of simultaneously sending telegraphic and telephonic signals along the same line.

I believe that the propagation of magnetic impulses along a bar of iron has to be studied in an entirely different way. We intend to make an attempt in this direction ere long.

Utrecht, July, 1892. V. A. JULIUS.

"The Limits of Animal Intelligence."

CLOSELY in connection with an observation I made the other day with respect to an argument of Prof. Pearson's, I should like to say a few words about a paper read by Prof. Lloyd Morgan before the International Congress of Experimental Psychology, on "The limits of animal intelligence." The first proposition he advanced, "That human psychology is the only key to animal psychology," and the deductions he subsequently drew, all implied that our knowledge of human psychology differed not only in degree, but in kind, from our knowledge of that of animals. Of course it is true that my knowledge of *my own* psychology does differ in kind from my knowledge of that of animals, but it differs in exactly the same way from my knowledge of that of all other men. If in no case is "an animal activity to be interpreted as the outcome of the exercise of a higher psychical faculty, if it can be fairly interpreted as the outcome of one which stands lower on the psychological scale," the same rule should be applied to the interpretation of human activities, for the only reason for distinguishing between human and animal psychology is that their activities do, as a matter of fact, differ. Human beings are of course distinguished from animals in other ways; in the structure of their limbs, for example; but there is no *a priori* ground for inferring from such differences any, and certainly not any particular, difference in psychological powers. And so far from its being permissible to infer such a difference from greater or less complexity of brain-structure, it is only because animals which when alive displayed great activities proved, on dissection, to have possessed complex brain structure, that we can infer any connection whatever between the two phenomena. As no man has ever dissected his own brain he cannot say that any particular structure is associated with those psychological powers of which alone he has any more direct knowledge. If, for example, I say "Morality involves a perception of the relation between the actual and ideal, and is based on introspection," I say this in consequence of my personal experience. I can only infer morality, introspection, and so on, in other beings, whether animals or men, by judging from their activities. And if "most cases of so-called morality in the dog can be otherwise interpreted," so also can most cases in other men. A fundamental distinction between the psychological powers of animals and men could only be established by showing a fundamental distinction between animal and human activities, as observed from outside by a third person. And though it is easy to show that there is a difference in degree, Prof. Morgan did not adduce any cases which even tended to show that there is any difference in kind. The cases he did adduce all tended the other way; and though this was doubtless because he only adduced difficult cases in order to show that his theory was capable of explaining them away, his explanations seemed to me, for the reasons I have given, insufficient.

Note.—The quotations are from a printed *précis* of his paper distributed by Prof. Lloyd Morgan at the meeting.

EDWARD T. DIXON.

12, Barkston Mansions, South Kensington, August 5.

Tropical Cyclones.

A FEW years ago I drew up some simple mathematical rules to aid the Jamaica Weather Service when in doubt as to the indications, and thinking that these rules may be of some use to other isolated or nearly isolated stations in the Tropics, I state them here, and give an example or two as to their application.

At the time and place of observation let

p = Reading of bar in inches and decimals of an inch, corrected for instrumental error, reduced to 32° F. and sea-level, and further corrected for diurnal variation.

p_m = Mean value of p for the time of the year.

$\Delta p = p_m - p$ = fall of pressure below the mean.

v = Velocity of the wind in miles per hour.

r = Distance of the centre of the cyclone in miles.

$\frac{dp}{dr}$ = Bar-gradient, or the fall of p per mile towards the centre at the place of observation.

$\frac{dp}{dt}$ = Rate of fall, or the fall of p per hour.

$\frac{dr}{dt}$ = Rate of approach of the centre in miles per hour.

Now let us suppose that the centre is moving towards the place; in this case we have

$$\frac{dr}{dt} = \frac{\frac{dp}{dt}}{\frac{dp}{dr}} = \frac{\text{Rate of fall}}{\text{Gradient}} \quad \ldots\ldots (1)$$

In Jamaica $\frac{dp}{dr}$ is found by an exchange of telegrams between Kingston and Kempshot, these places being on the line of usual approach, and 77 miles apart.

The next equation is based upon the results of observation:—

$$r = \frac{\Delta p}{2\frac{dp}{dr}} = \frac{\text{Fall below mean}}{\text{Twice the gradient}} \quad \ldots\ldots (2)$$

This equation must not be pressed; it is intended to be used when the centre is still a long way off.

Thus we have

$$\text{Time of arrival of the centre} = \frac{r}{\frac{dr}{dt}} = \frac{\text{Fall below mean}}{\text{Twice the rate of fall}} \quad \ldots\ldots (3)$$

This is an important equation, for it shows that the direct approach of a cyclone may be ascertained by the constancy in the computed time of arrival.

As an example, let us take the cyclone which passed over Kingston, Jamaica, August 18, 1880. This was before the Weather Service was established, and the indications of the advancing cyclone were confused by the existence of a small cyclone to the north-east of Kingston; there was no wind in Kingston until 8 p.m., and rain fell quietly in showers all that afternoon from a sky covered with stratus.

Kingston, Jamaica, August 18, 1880.

	p	Δp	$\frac{dp}{dt}$	Time of arrival.
7 a.m.	29·845			
9 ,,	·807	0·178	0·0170	2 p.m.
11 ,,	·777	·208	·0142	6 ,,
1 p.m.	·750	·235	·0120	11 ,,
3 ,,	·729	·256	·0225	9 ,,
5 ,,	·660	·325	·0595	8 ,,
7 ,,	29·491	0·494	0·1808	8.30 ,,
9 ,,	28·937			

From the last column it appears that from 7 a.m. to 1 p.m. the cyclone was not directly approaching, and from the logs of vessels and other information it is certain that the cyclone was passing south of Jamaica on a westerly course, and that between 1 and 3 p.m. it turned on its course and advanced directly towards Kingston. The centre arrived at about 9 15 p.m., lowest $p = 28·917$.[1] A warning notice was posted at 3 p.m., but had these rules been in existence, a better notice could have been posted at 5 p.m.

Now if the gradient be not known at an isolated station, it may sometimes be deduced from the theoretical equation—

$$\frac{dp}{dr} = 0·00007v \quad \ldots\ldots (4)$$

This equation is only to be used for considerable distances from the centre; and if v be small, or variable, or if it be mixed up with the sea-breeze, it cannot be used at all.

If $\frac{dp}{dr}$ be known, r is known from (2), and then some idea may be formed as to the magnitude of the coming disturbance. The following rule may prove useful:—

Let Δp_c be the fall below the mean at the calm centre of the cyclone; then, roughly—

$$\Delta p_c = \frac{\Delta p\sqrt{r}}{6}\left(1 + \tfrac{3}{4}\Delta p\sqrt{r}\right) \quad \ldots\ldots (5)$$

Now $\frac{dp}{dr}$ is unknown in the example above; but if we take $\frac{dr}{dt} = 18$ from the subsequently known circumstances, (1) gives $\frac{dp}{dr} = 0·0012$ at 3 p.m.; (2) gives $r = 106$ at the same hour which happens to be right; and (5) gives $\Delta p_c = 1·3$, which is a little too large, the observed fall at the centre being about 1·1.

As another example, let us take the great hurricane in Mauritius on April 29 this year. Some valuable notes by Dr. Meldrum are published in NATURE, June 9, but unfortunately the readings of the barometer are not corrected for diurnal variation, although the given values of $\frac{dp}{dt}$ are so corrected; and I can only apply approximate corrections, and so obtain approximate values of Δp.

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[1] See "Jamaica Meteor. Obs.," vol. i. (Introduction).

Mauritius, *April* 29, 1892.

	p	Δp	$\frac{dp}{dt}$	Time of arrival.
6 a.m.	29·668	0·282	0·018	2 p.m.
8 ,,	·597	·353	·029	2 ,,
9 ,,	·536	·414	·063	1 ,,
10 ,,	·440	·510	·094	1 ,,
11 ,,	29·304	0·646	0·131	1.30 ,,

The computed time of arrival is therefore 1.30 p.m., and the agreement in the last column shows that the centre was directly approaching the place of observation, and it really arrived there at 2, or 2.30 p.m.

Now at 6 a.m. the wind was 22·4 miles an hour: (4) gives $\frac{dp}{dt} = 0·0016$; (2) gives $r = 104$; and (5) gives $\Delta p_c = 1·5$, which is a little too small, the observed fall at the centre being about 2·0. If, however, we compute Δp_c for 9 a.m., we get 2·4, which is a little too large; and as in the case of time of arrival, we should be guided by a series when possible.

Jamaica, July 29. MAXWELL HALL.

A Sparrow's Antipathy to Purple.

I HAVE but just seen your number for March 10. About five years ago I knew a tame sparrow with a great antipathy for purple. It was brought up in a room, but not, or seldom, caged. It lived four or five months. A piece of blue paper placed over its food would cause it to hesitate, though if hungry it would eventually draw the paper aside; a person coming into the room wearing a blue dress would make it quite wild, and a habit of mischievously pecking at a certain part of the wall of the room was successfully stopped by hanging a piece of blue paper there. This sparrow was taught to be cleanly in its habits. I had put off writing this to you in hopes that others who saw more of the sparrow would have written a more detailed account, but trust this letter may not be too late for any one interested to get a young sparrow from the nest this year and rear it. Sparrows have not yet reached Borneo. G. D. HAVILAND.

Sarawak, June 17.

Bumping in the Lane Fox Mercurial Pump.

CAN any reader of NATURE favour me with a method by which the bumping in the Lane Fox pump may be obviated? I find that when exhaustion is pressed to a certain point, the bumping becomes so violent, in spite of the utmost care in lowering the reservoir, that the bulb of the pump is constantly cracked. D. G.

Lahore, July 25.

CARL SCHORLEMMER, LL.D., F.R.S.

CARL SCHORLEMMER having been my friend and colleague in Owens College for more than thirty years, it is with a sad pleasure that I take up my pen to record in the columns of NATURE some few details of his character and work. He had not, like his predecessor Dittmar, been a fellow student with me in Heidelberg, but had worked at chemistry in Darmstadt, where he was born, and at Giessen. In 1858 Dittmar, who up to that year had been my private assistant, obtained the College appointment of Demonstrator, and he strongly urged me to offer his vacant post to his friend Schorlemmer, a young man of great promise. From the time of his arrival in Manchester until the day of his death I do not recollect that in all the intercourse of those years Schorlemmer and I ever had a single serious difference. Whilst my private assistant he and I examined the relation which the aqueous acids exhibit as regards boiling point and composition, and I remember well the difficulties we had to contend with in distilling fuming nitric and hydrofluoric acids under pressure, and I also remember how successfully he met them. Once, I know, he got some fuming hydrofluoric acid on his hand, and he bore the scar of the serious burn to the end. This work with me was his apprenticeship. In a short time Dittmar left us, and Schorlemmer took his place as the official Laboratory Assistant, and as we had not many students at that time, he had leisure to begin the hydrocarbon work which has placed his name high in the list of organic chemists of the century. In 1861 the late Mr. John Barrow, of the Dalton Chemical Works, Gorton, brought me a sample of the light oils which he had obtained in the distillation of cannel coal. At that time our knowledge of the chemical composition of the low-boiling coal-oils was very incomplete, and I urged Schorlemmer to undertake the investigation. This was the beginning of the work which led to a result which altogether modified the existing ideas concerning the constitution of the paraffin hydrocarbons, and paved the way for the sound foundation upon which the organic portion of our science has since been successfully laid. In order to appreciate Schorlemmer's results let us for a few moments glance at the position of the question when he commenced work. Before 1848 the only known member of the paraffin series of hydrocarbons, was methane CH_4. In the above year the researches of Kolbe on the electrolysis of the fatty acids, and of Frankland on the isolation of the alcohol-radicals, opened out new fields yielding a rich harvest. Each molecule of these latter hydrocarbons was supposed to contain two molecules of the radical methyl being represented as $\left.\begin{matrix}CH_3\\CH_3\end{matrix}\right\}$, whilst together with these a second series of hydrides was believed to exist, $\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}$ ethyl hydride standing in the same relation to the radical as an alcohol does to an ether. The truth of this view seemed confirmed by Wurtz's discovery of the existence of the so-called mixed radicals in which two molecules of different hydrocarbons, such as ethyl and amyl $\left.\begin{matrix}C_2H_5\\C_5H_{11}\end{matrix}\right\}$ occurred. How was this question to be settled? Schorlemmer at once seized upon the correct method of solution and carried it out successfully. If, said he, the radical methyl $\left.\begin{matrix}CH_3\\CH_3\end{matrix}\right\}$ is identical with hydride of ethyl $\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}$ not only must these two bodies possess the same properties, but both bodies must yield the same product, viz., ethyl chloride, on treatment with chlorine. This identity he proved, not only in the above—the most simple case—but in the more complicated cases of ethyl-amyl $\left.\begin{matrix}C_2H_5\\C_5H_{11}\end{matrix}\right\}$ and of di-amyl $\left.\begin{matrix}C_5H_{11}\\C_5H_{11}\end{matrix}\right\}$ as these hydrocarbons yielded respectively chloride of heptyl and chloride of decatyl, $C_7H_{12}Cl$. and $C_{10}H_{21}Cl$. It is difficult to overrate the importance of this apparently simple discovery. It laid for ever the ghost of the existence of two sets of isomeric hydrocarbons of the paraffin series, and paved the way for Kekulé's theory of carbon combination, upon which the whole modern theory of organic chemistry is based. So to Schorlemmer belongs the credit of placing in position the foundation-stone of our science. And at once his name became known as a master wherever chemistry is studied; so that in 1871 the Council of the Royal Society admitted him to the Fellowship at once, an honour conferred nowadays on few.

But it was not only as an expert experimentalist that Schorlemmer excelled, and his thirty-two papers catalogued in the Royal Society list prove that he was a successful one. He possessed an exhaustive knowledge, uncommon amongst chemists, of the literature of his special science in all its varied departments. If any of our men wanted a quick reference to either recent or ancient work, it was always "Go and ask Schorlemmer," and they seldom came empty away. But his acquaintance with other sciences was also considerable. If he had not been a distinguished chemist he would have made an equally distinguished botanist. He likewise possessed in full measure that dogged power of work which distinguishes the German. I was especially fortunate in securing his co-operation as co-author of the Treatise. The success of my little book—as to which no one was more surprised than myself—induced me to set about the task of writing a larger and more complete work. I soon found that the other very various and pressing duties of my position rendered it impossible for me to do all the work myself, and my friend Schorlemmer joined me in this somewhat laborious business. To him the organic part almost entirely owes its being, whilst in the inorganic portion his assistance and suggestions were most valuable. We published the book simultaneously in Germany and England, and it is not too much to say that in both countries the work has become a standard one. For the last few years of his life this was his main work. Only those few men who have lately attempted the task of writing even a moderately complete treatise on modern organic chemistry can know what serious labour such work entails. Several distinguished chemists have given up the task as hopeless, and have not completed what they had begun. If Schorlemmer's life had been spared he would have brought his work to a conclusion, cost what it might. Our consolation—and it is but a poor one—at his early death (for he was only fifty-eight), must be that, so far as the chemistry of the hydrocarbons and their derivatives are concerned, his manuscript is complete, and in the hands of Messrs. Vieweg. A mass of material he has gathered together for the remaining organic compounds in which nitrogen occurs as a constituent element. It will be my task to see whether this last portion of the work is complete, and if not, how it can best be brought up to the level of the day.

As a historian of our science, I think that the designation of him by his German friends as the "English Kopp" is a just one. Only a few weeks before his death he talked to me with pleasure of the results of his work on an introduction to the history of chemistry, which had engaged his attention for many months past. Fortunately, he had the rare power of writing so that his manuscript was at once ready for press. Hence, although a fragment, his history so far as it goes—and I believe it goes as far as the end of the eighteenth century—is complete. We shall all look with interest to its speedy publication, and from what I know of the author's works and ways, I shall be disappointed if this fragment does not throw a new light on many dark pages in the early history of our science. One word more as to his character. I have said that we never had a difference, and I believe from what I know of his other friends that they would say the same. He was of a retiring, most modest, and unassuming disposition. To only a few of his intimates, German and English, were his true colours visible. As a laboratory teacher he was excelled by few, merely as a lecturer by many. But although, like some other eminent lecturers, his diction may have been faulty, the staple article was there, and I never met a real student amongst all those who passed through his hands who did not express his admiration for the man, and his sense of the obligation which he felt for the masterly instruction which the Professor always and most readily gave, whilst the long list of honours which his men gained in organic chemistry, both at London and afterwards at Victoria, proved that his teaching was not in vain. True to his science, he valued chiefly the respect and affection of his colleagues and pupils. In society he did not shine, nor did he take any leading part in the government of the College or in the foundation of the University, although those of us who were more active in these matters could always count upon his support in all questions in which the interests of science were concerned, and if he usually preferred to be at his own desk rather than to spend his time listening to the often tedious discussions of the Senate meetings, he was always at hand when a vote was needed to carry out some measure of scientific reform. Although for many years a naturalized Englishman, and enjoying and appreciating English freedom and English ways, he retained more than is usual, a lively interest in the welfare of the "Vaterland." I knew but little of his political views, for these he did not obtrude on his friends, though he held decided ones. He believed in popular freedom and popular rights, and was a strong supporter of the German Social Democratic party, many of the leaders of this movement, both in Germany and in England, being his intimate personal friends. But with these matters we here have little to do. We here have to recognize the scientific work which he has done amongst us, to record our appreciation of that work, and to express the regret of all interested in science at his untimely death.

H. E. Roscoe.

SCIENTIFIC INVESTIGATIONS OF THE SCOTTISH FISHERY BOARD.

The Fishery Board for Scotland has issued its Tenth Annual Report (for the year 1891). It is divided into two parts—the general report, and the report on salmon fisheries. We reprint from the general report the passage relating to the scientific investigations carried on since the Board was reconstituted ten years ago:—

The following is a statement of the sums which have been sanctioned during each of the following years and spent by the Board on scientific investigations:—

Year.	Sanctioned.	Spent.
1883–84	£300	£300 13 7
1884–85	1600	1430 0 11
1885–86	1500	1500 0 0
1886–87	2000	1647 5 3
1887–88	2000	1843 4 5
1888–89	2000	1804 4 3
1889–90	2000	2026 10 0½
1890–91	1800	1792 13 4
	(With £200 for travelling expenses.)	
1891–92	£1800	Do.

In addition a sum of £2500 was applied in 1886–87 for the purchase of the steamer *Garland*, and £500 per annum allowed for its maintenance, which was increased first to £900, and afterwards to £1200 a year.

When the Board commenced its operations, it was a new departure in State administration. The Fisheries Commission of the United States was only established in 1871, and we were without the experience which has since been gained in America, Germany, Norway, and other countries bordering on the North Sea. The directions of the Act of Parliament creating the Board were very general. We were appointed to "take cognisance of everything relating to the coast and deep sea fisheries of Scotland, and take such measures for their improvement as the funds under their administration not otherwise appropriated might admit of, but without interfering with any existing authority or private right." Hitherto the fisheries had been practically left to take care of themselves. During the administration of the old Board, which had existed from 1809 under the name of the Commissioners of the British White Herring Fishery, scientific investigations had indeed been made from time to time into special points, such as the spawning of the herring, the capture of immature herrings by sprat fishermen, and the action of the beam-trawl on herring spawning-beds. These inquiries were, however, limited both in character and extent, and were merely incidental to certain questions prominent for the time being. The absence of definite scientific knowledge relating to the fisheries had been felt and commented upon by Royal Commissions appointed to enquire into fishing questions; and when the new Board came into existence in 1882, it was found that, without further information as to the habits and life-history of the food-fishes, it would be impossible to submit satisfactory reports to Parliament either as to the improvement or the regulation of the fisheries. It was accordingly resolved that scientific investigations should be instituted under a committee, consisting of Prof. Ewart (Convener), Sir James Maitland, Sheriff Forbes Irvine, and Mr. Maxtone Graham. This committee acted until 1886, when it was dissolved; and, in 1887, another committee was formed, consisting of Prof. Ewart (Convener), Sir James Maitland, Mr. William Boyd, and Mr. W. Anderson Smith, which continued till 1889. Since the dissolution of this committee the scientific work has been under the immediate control of the Board, with Dr. T. Wemyss Fulton as scientific secretary, but all the members feel, and desire specially to acknowledge, the valuable assistance which has been rendered by Sir James Maitland and Mr. Anderson Smith.

Before describing the investigations undertaken, a word must be said as to the means which have been at the disposal of the Board. In 1884 a marine laboratory was established at St. Andrews, with the co-operation of Prof. McIntosh, F.R.S., who was at the time engaged in making scientific investigations for the Royal Commission on Beam-Trawling, under the late Lord Dalhousie; and this laboratory has continued in active operation ever since under Prof. McIntosh's charge. In 1885 another laboratory was erected at Tarbert, Lochfyne, which was placed under the charge of Mr. George Brook, F.L.S., and was occupied until 1887. During 1886–87 a portion of Rothesay Aquarium was made use of, and from 1884 until 1889 part of the scientific work was carried on at the Natural History Department of the University of Edinburgh, under the charge of Prof. Ewart. Subsequently a marine laboratory was built at Dunbar, which has since been added to, and in connection with which the Board are now erecting a large hatchery for the propagation of sea-fish. In addition to the laboratories mentioned, the fishery cruisers have occasionally been engaged in aiding the scientific inquiries, as have also the staff of Fishery Officers around the coast. Since 1886 the small steam-vessel *Garland*, although not at all sufficient for the work, has also rendered important services.

At the time when the scientific investigations were begun very little was known regarding the habits of sea-fishes. Fishermen, who presumably ought to know something of the life-history of the fishes they catch, knew, as Prof. Huxley has remarked, very little beyond the best way to catch them. Yet from the earliest period until comparatively lately, the practice has been to shape fishery legislation in accordance with local desires or the popular opinion prevailing at the time, and not upon ascertained conditions. A study of the statutes dealing with sea fisheries, especially those passed by Parliament from the middle of last century to about the middle of this, shows that vast sums of money have been expended uselessly, and injurious restrictions imposed for reasons which scientific investigations have now proved were illusory. About thirty years ago, however, an important change in this system was effected. Van Beneden on the continent, and Prof. Huxley, Mr. Spencer Walpole, Mr. Shaw Lefevre, and others in this country made a stand against haphazard regulations, and in Great Britain their action found practical expression in the liberating Act of 1868 (31 and 32 Vict. c. 45), which repealed or amended sixty-four fishery statutes, and restored liberty of fishing. The Royal Commissioners who brought about this reform (the late Sir James Caird, Prof. Huxley, and Mr. Shaw Lefevre) refer in their report to the absence of knowledge about the habits of sea fishes, their reproduction, spawning-places, and conditions of existence which is essential to effective regulation of the fisheries.

An indication of the lack of accurate knowledge on these subjects as lately as 1883 was afforded at the London International Fishery Exhibition in 1883, when a high authority thus described the condition of things at that time: "It is a very striking fact that the one point on which all speakers at the conferences held during the past summer at the Exhibition were agreed was this—that our knowledge of the habits, time and place of spawning, food, peculiarities of the young, migrations, &c., of the fish which form the basis of British fisheries, is lamentably deficient, and that without further knowledge any legislation or attempts to improve our fisheries by better modes of fishing, or by protection or culture, must be dangerous, and indeed unreasonable."

It is a source of satisfaction to the Board that their labours in this field of fishery work, even for the comparatively short time over which they have extended, have yielded successful results, and have contributed materially to the advancement of that knowledge of fishery problems, the want of which was felt and deplored by the Royal Commissioners of 1866. The scientific work carried on by the Board, the chief results of which have been described from year to year in their annual report to Parliament, may be summarized briefly as follows:—

(1) Inquiries into the influence of beam-trawling on the fish supply, especially within the territorial waters; the capture and destruction of immature fish by various modes of fishing; the condition of the inshore fisheries for shell-fish and the supplies of mussels and other bait for line fishermen; surveys and examination of the fishing grounds, &c.

(2) Investigations into the food, fecundity, reproduction, habits and migrations of the food fishes, the location of their spawning-grounds, and of the nurseries of young fish, the time and duration of spawning, &c.

(3) The study of pelagic and demersal ova, and of the development of the food-fishes and edible molluscs from the egg onwards.

(4) Inquiries into the micro-organisms in river waters, and associated with salmon disease, and into the food of fishes in inland waters.

(5) Observations on the temperature, salinity, and physical conditions of the sea around the coast.

(6) The artificial propagation of sea-fish and shell-fish to re-stock depleted grounds.

The investigations into the influence of beam trawling, which have been carried on with great regularity and care, have furnished a mass of scientific and statistical evidence unexampled in the history of any fishery, and have been followed by the prohibition of this mode of fishing within the territorial seas. As stated in former reports, various portions of the inshore grounds were for experimental purposes closed against beam-trawling, and by the Herring Fishery (Scotland) Act of 1889, the territorial waters were included in the prohibition, certain powers being reserved to the Fishery Board. Closely related to beam-trawling is the capture and destruction of immature fish, which is generally regarded as the most important of the fishery problems awaiting solution in the immediate future. In certain foreign States and English fishery districts the landing or sale of immature fish under certain sizes has already been made penal; and in 1890 an International Fishery Conference was specially convened in London to consider this subject so far as it affected the diminution of the fish supply from the North Sea. Extensive observations have been made by the Board as to the distribution of immature fish on the east coast of Scotland at various distances from shore and in water of different depths; the minimum size at maturity of the different species and the proportions captured by various modes of fishing, with especial reference to the mesh of trawl-nets, have been ascertained, as has also the action of the beam-trawl in destroying immature fish according to the time the net is down and the nature of the bottom. The results were embodied in a report which was prepared by Dr. Fulton, under directions of the Board, and was described (we believe with perfect accuracy) by the vice-president at the Conference "as one of the most important, if not the most important, document that had up to the present been contributed to the Fishery literature of this country."

The inquiries into the food and propagation of the edible fishes have been also prosecuted on an extensive scale. The food-material of nearly 20,000 specimens caught at various parts of the coast and at all seasons of the year has been examined, and this research has yielded valuable results both in regard to the protection and regulation of the fisheries and the increase of the fish supply by artificial means. The fecundity of nearly all the food-fishes has been determined, the nature of pelagic and demersal ova has been carefully studied, and the distribution of the former in the waters over the breeding grounds and along the coasts investigated. The development from the egg onwards, and the characteristics of the young of the majority of the edible fishes have been described—including the herring, haddock, whiting, cod, ling, turbot, plaice, lemon sole, flounder, &c., and also of the most valuable forms of bait, the mussel and the clam. The spawning of the herring and of the other food-fishes has received special attention. Since 1888 upwards of 30,000 white fish—such as cod, turbot, plaice, &c.—have been individually examined. By this means the time and duration of the breeding season has been determined, and the important fact has been proved that on the east coast of Scotland, where the investigation was mainly carried on, the spawning-grounds of the valuable food-fishes (cod, haddock, plaice, turbot, &c.) generally lie outside the territorial limit—contrary to the belief formerly held—and that only forms of comparatively little value, such as the flounder, dabs, and gurnards, &c., spawn within the three-mile limit. The importance of these facts cannot be over-estimated. They bear directly both on the question of establishing a close-time and the measures proper to be taken for the regulation of fishing on the breeding-grounds. The trawlers, driven outside the inshore waters, generally take to the breeding-grounds, for there the hauls are most abundant. The significance of this fact, in connection with the falling off in the inshore fisheries, is becoming too grave to be longer overlooked. The growth of population has been followed by an increase in the demand for fresh fish, the extension of the means of distribution has ministered to this demand, and if the floor of the ocean is to be swept without public regulation, the ordinary fishing-grounds will prove inadequate to maintain the supply. The destruction of spawning fish is proving a serious evil. In Germany, where this matter has been carefully examined, it is now held to be more important to protect the spawning-banks, than to prevent the destruction of immature fish. Some of our fisheries are, in fact, in danger of being exhausted unless judicious regulations are rigidly enforced.

During the last three years experiments have been carried on to determine the migratory movements of fish, and nearly 3000 have been labelled and returned to the sea. A percentage of these has been recovered, and steps are now being taken to apply the same method on a large scale to the herring. The experiments are not sufficiently advanced to justify any final conclusion as regards all fish, but undoubtedly as regards many of them the facts already ascertained prove that until they reach a certain size they do not leave the territorial waters.

The means of increasing the diminishing fisheries for shell-fish have received careful attention. Surveys have been made of the more important mussel-beds on the east coast, the extensive clam-bed in the Firth of Forth, the cockle beds at Barra, and a detailed examination of the great mussel-growing area in the Clyde is at present in progress. The French system of growing mussels on wattled bouchots has been tested side by side with the bed-system, and a series of experiments have been made on board the *Garland* to test the comparative efficiency of different natural baits, and of various artificial substitutes. A physical and biological investigation has also been made of a number of sea-lochs on the west coast, in order to ascertain their suitability for the growth and culture of oysters (the Scottish oyster having sunk to a very low point), and a special lobster pond has been constructed at Brodick, Arran, in which about 200,000 young lobsters were hatched last year.

The physical observations into the temperature and salinity of the sea have been carried on on board the *Garland* and the fishery cruisers, and at ten fixed stations daily—five on the east coast and five on the west. By the courtesy of the Northern Lighthouse Board, observations are allowed to be taken daily at the Bell Rock and Oxcar Lighthouses, the lightship at the North Carr, and also at the mouth of the Tay. Many thousands of observations are thus made every year, and several valuable reports have already been published.

From this brief summary of part of the work done, it will be seen that considerable progress has been made since 1883 in extending the knowledge of the habits and life-history of the food-fishes; and it is gratifying to learn that the results obtained by the Board have been gratefully acknowledged by high authorities, and found useful in other countries.

In recent years the attention of the authorities of various maritime States, especially those around the North Sea, but also in the Mediterranean and in America, has been forcibly called to the diminution of the fish-supply within the territorial seas and on much-frequented fishing banks off shore. The falling off in the supply of valuable flat fishes, such as turbot, sole, and plaice, from the North Sea, has led to various conferences of those engaged in the fishing industry. At the International Fishery Conference held in London in 1890, at which representatives were present from Germany, Denmark, Holland, France, Belgium and Spain, it was resolved that scientific investigations should be carried on by each country, particularly into the capture and destruction of immature fish by the beam-trawl, prior to the assembling of an official International Conference to deal with the subject by international agreement; and at a conference of representatives of the fishing industry held in London last February resolutions were passed, that in view of the diminution of the valuable food-fishes, the hatching of sea-fish should be undertaken on a large scale, and measures adopted to prohibit the sale of immature flat fishes under a certain size. The decrease in the fish supply from the off-shore banks has not yet become so marked off the Scottish coast as is the case further south; but from the statistics given below as to the yearly increasing number of Scottish beam-trawlers; the flocking northwards of English vessels from their own depleted grounds; and the actual diminution in the quantity of flat fish landed there is reason to apprehend that in the course of very few years a similar result will be brought about here. As has been stated above, the Board are at present having erected at Dunbar, by means of the ordinary vote for scientific investigation, on a site granted by the War Office and the Council of the Burgh, a large hatchery for sea-fish, with the necessary tanks and pumping apparatus, which, when complete, will permit of several hundreds of millions of the food-fishes being hatched every season and planted on the fishing-grounds. It will therefore be possible for the first time in this country to adopt active measures to directly add to the fish supply, as has already been done in the United States, Norway, Canada, and Newfoundland.

NOTES.

AMONG the honours announced at the change of Ministry the Privy Councillorship conferred upon Prof. Huxley not only establishes a precedent, but affords an indication that the neglect of the claims of men of science, whether they be servants of the Crown or not, to the ordinary national distinctions is not likely to be so marked in the future as it has been in the past. Six years ago or thereabouts, Prof. Huxley was allowed to leave the public service without the slightest recognition of the value of the work he had done in many capacities during some forty years. No better way of making the so-called "honours" ridiculous can be found than in generally omitting to confer them upon persons of distinction—persons known to the nation as devoting their lives to the national welfare in some walk or other.

WE have learned with regret a rumour to the effect that th Admiralty has declined to render the assistance in carrying observers and instruments for which the Royal Society made application some time ago to further the observations of the total solar eclipse in Senegambia next April. If this be confirmed, the expedition will in all probability be abandoned. Such a state of things requires no comment of ours.

A MEETING of the Swiss Society of Natural History is announced to take place at Basle, from September 4 to 7, under the Presidency of Prof. Hagenbach-Bischoff, and the following communications have been aranged for:—"The Origin of Swiss Lakes," Prof. A. Heim, Zurich; "The Thermal Conditions of the Lake of Geneva," Prof. F. A. Forel, Morges; "The Biological Conditions of the East-African Steppe," Prof. C. Keller, Zurich; "The Metamorphosis of Alpine Rocks," Prof. C. Schmidt, Basle; "The Evolution of Human and Animal Physiognomy," Prof. W. His, Leipzig; "Studies on the Veddahs, the Aboriginals of Ceylon," Dr. Fr. Sarasin, Berlin. A special invitation is given to foreign students to join the meeting.

ACCORDING to the *Times* a telegram has been received from Tromsö announcing that the *Manche* which left Leith on July 20, for Jan Mayen Island, in the Greenland Sea, reached its destination on the 27th. The island had not been visited for ten years. The vessel went round it and then proceeded to Spitzbergen, where it made important collections of reindeer, foxes, birds, and fossils in Ja Fiord and Bel Sound.

MR. RISELY GRIFFITHS, the Administrator of the Seychelles, visited the Island of Aldabra in May last. In a report to the Colonial Office communicated to Kew, he gives the following particulars respecting the gigantic land tortoises :—"The following morning I went on shore to visit Mr. Spurs' establishment, and observe some of the natural peculiarities of this extraordinarily-formed island, which, except here and there, appears to be one mass of very ancient coral, which has been washed for so many centuries by the sea that all the softer portions have been washed out, and the remainder is hard and ragged, and therefore is difficult to walk over. Curious to state, small trees, shrubs and vines flourish over it, and in these inextricable places, which are of vast extent, do the enormous land tortoises find a genial and apparently prolific existence. When Mr. Spurs first went to Aldabra he was of opinion there were very few of them left ; but he now states that there cannot be less than one thousand in all the island. I made him repeat this statement more than once, as I was sceptical about so large a number ; but he assured me that a few hundreds would not accurately describe their number."

THE Tuesday evening lectures at the Royal Victoria Hall, Waterloo Bridge Road, will be resumed in September, and on the evenings of September 6, 13, and 20, respectively, Prof. B. J. Malden will lecture on "The Wonders of the World," "A Holiday in Sweden and Denmark," and "Australia."

ACCORDING to the *North British Agriculturalist* the plague of voles from which farmers in the Border districts have for some time past suffered much inconvenience and loss, is, notwithstanding the strenuous efforts put forward for the abatement of the plague, on the increase. The grass lands are so thickly set with the nests of the voles that much difficulty is experienced in cutting them, and the vermin are now making their abode in the corn-fields, which are in consequence also being destroyed.

CÁNOVAS AND TRAYNOR, 3 Calle de Santa Catalina, Madrid invite subscriptions to a facsimile reproduction of the first geographical chart of America (1500), by Juan de la Cosa, Columbus's sailing-master in his first and second voyages. It will be printed in the original colours, from which black, by the way, is absent. The work will be published in three forms, one—the popular—at 12s., another in vellum at 20s., and the third in parchment at £20. The parchment edition will be hand coloured.

PROF. FLÜCKIGER has sent to the President of the Pharmaceutical Society, as representing the British subscribers to the Flückiger testimonial, a bronze replica of the medal which was presented to him, and expresses the hope that it will be accepted as a sign of his gratitude and a slight proof of his appreciation of the friendship and encouragement he has always met with in England.

WE extract from the *Bollettino Mensile*, of the Meteorological Observatory of Riposto, the following details respecting the recent eruptions of Mount Etna. The crater had shown extraordinary activity from the beginning of July, and on the night of the 8th–9th, a severe shock in all the surrounding region announced the probability of an approaching eruption. At 1.20 p.m. on the 9th the south slope of the mountain burst open, at about 5000 feet above the sea, forming at once several mouths emitting lava, stones, and incandescent masses, as well as enormous quantities of sand and black smoke. At times large blocks were hurled to a height of about 1300 feet. Several of the mouths united, and formed three craters in an almost direct line from north to south, from two of which the lava encircled Monte Nero like an enormous river, while the third emitted masses of stones and cinders. The eruption continued with more or less intensity all the month, but showed signs of diminishing on the 31st. The lava devastated much fertile country, but fortunately its course was checked by the deposits of former eruptions ; if this had not been the case several of the villages would have been in great danger. This eruption was noteworthy for the enormous quantities of smoke and sand emitted, and for the scarcity of seismic motions ; the lava resembled physically that emitted in the eruptions of 1883 and 1886.

THE thirty-ninth Report of the Department of Science and Art of the Committee of Council on Education is now ready, as is also the Directory (revised to June 1892), with regulations for establishing and conducting science and art schools and classes.

MESSRS. GIBBONS, of Liverpool, have issued a small handbook respecting the Department of Engineering in connection with University College, Liverpool, which should prove of much service to intending students, who will find in it all the information they are likely to require with reference to fees, subjects, evening lectures and classes, scholarships, certificates, &c., &c.

THE twenty-fifth annual report of the Peabody Institute of the City of Baltimore has been issued, and seems in every respect highly satisfactory. Incandescent electric lamps and appliances have been placed in the large hall and reading-room during the year, accessions to the library have been numerous and valuable, and the lectures were attended by larger audiences than in the preceding year. Another encouraging item in the report is that there was an increase in the number of applications for books relating to science, amongst the subjects which appear to have grown in favour being anatomy, astronomy, chemistry, mathematics, medicine, and natural history.

THE annual announcement of Courses of Instruction in the Colleges at Berkeley, Cal., for the academic year 1892–93 has recently been issued.

THE Calendar of University College, Bristol, for the Session 1892—93, has just been issued.

THE second edition of Mr. W. F. Kirby's "Elementary Text-Book of Entomology" has been published within the last few days by Messrs. Swan Sonnenschein and Co. The author has not thought it necessary to make any extensive alterations in the text or plates, but the following additions have been made to the work :—An appendix, giving further particulars respecting many of the insects mentioned or figured, and a complete index.

IN the *Board of Trade Journal* for August are to be found articles on "Chemical Industry in Germany," the "Sicilian Sulphur Industry," and "Cinchona and Indigo Cultivation in India."

THE current number of the *Journal of the Society of Arts* is, in the main, devoted to the publication of Prof. George Forbes' first lecture on "Developments of Electrical Distribution."

THE June number of the *Agricultural Gazette of New South Wales* contains the continuation of two articles by Mr. P. Turner, on "The Grasses of Australia," and "New Commercial Crops for New South Wales," "Notes on Economic Plants," "The Sugar Cane Disease on the Richmond and Clarence Rivers," and many other items of interest.

THE *Korean Repository* for June, which has just come to hand, has an interesting article by Rev. D. L. Gifford on "Ancestral Worship as practised in Korea."

MESSRS. CROSBY LOCKWOOD AND SON announce for early publication a new work by Mr. J. E. Gore, entitled "The Visible Universe, Chapters on the Origin and Construction of the Heavens."

British Rainfall for 1891, compiled by Mr. G. J. Symons and Mr. H. T. Wallis, has been published, and in consequence of the exceptional character of the year of which it treats, is rather later in making its appearance than its predecessors have been. The Devonshire blizzard was the cause of much work, and praise is due to those observers who were brave and persevering enough to take their observations, notwithstanding the very exceptional difficulties by which they were confronted. One observer was barricaded with five feet of snow against every door, and another—a lady—finding that the wind had swept the grass clean all round the rain gauge and piled the snow more than five feet deep near the entrance gates to her house, wrote to enquire what she was to enter as the depth of the snow.

Symons's Monthly Meteorological Magazine for August contains a summary of the climate of the British Empire for the year 1891, compiled from sixteen representative stations. The highest shade temperature occurred at Melbourne, 103° in January. This is the first occasion since the publication of these interesting tables in 1884, that the temperature of Melbourne has exceeded both Adelaide and Calcutta. In connection with high temperature, attention is drawn to the record at Alice Springs in the centre of Australia, which shows an absolute shade maximum of 117° in December, and an average maximum of above 100° for the month. The extreme maximum in the sun 165°, and the lowest mean humidity 57 per cent, were recorded at Adelaide. Winnipeg, as usual, had the lowest shade temperature, – 34° ·5, in February, as well as the greatest total range 128° ·1, and greatest mean daily range 22° ·9. Ceylon recorded the highest mean temperature, 80° ·7, and also the least range in the year, there being only 24° ·3 between the maximum of the hottest day and the minimum of the coldest night. Malta usually has the smallest rainfall or the least cloud; this year, however, Adelaide had the least rainfall, 14 inches, and Bombay the least cloud, the average amount being 3·5. The greatest rainfall was at Colombo, Ceylon, 119 inches. It is unfortunate that both the West Indian returns have had to be omitted owing to incompleteness.

ABOUT the middle of last week the low pressure areas which advanced over this country from the south-westward caused a rapid rise of temperature in England, the maximum shade temperatures reaching 83° in the south and east. These conditions were accompanied by violent thunderstorms over the southern, midland, and eastern counties on Thursday and Friday, the area embraced by the storm extending from Devonshire in the west to Norfolk in the north-east, while the rainfall was very heavy, amounting to 1·4 inch in several parts. During the early part of the present week the temperature continued high over the greater part of England, being about 10° above the mean for the time of year, but was much lower in Scotland and Ireland. Conditions were again unsettled on the 23rd, and about 1·5 inch of rain was measured in the south-west of Ireland on that morning, while areas of low pressure lay over our south-west coasts, and severe thunderstorms occurred in the evening over all the southern half of England. The heat on the Continent has been excessive, the thermometer in the shade registering 100° and upwards at many stations, and even reaching 108° at Biarritz and Bilbao. During the last few days, however, the weather has become somewhat cooler over Europe, although very high temperatures were still maintained. During the week ended the 20th inst. the rainfall exceeded the mean in Ireland and Scotland, but in most of the English districts there was a considerable deficit (except in the south and east, where there was an excess, owing to the thunderstorms). There still exists a deficiency in all districts from the beginning of the year amounting to 5 inches in the south and to 8·6 inches in the south-west of England.

THE firm of P. J. Kipp and Sons, Delft, have constructed a new form of their electrodynamometer for the measurement of telephonic currents, in which several improvements have been introduced. As in the old form, in accordance with the suggestion of M. Bellati (Atti del R.I. Ven. 1883), a cylinder of soft iron wires takes the place of the usual movable bobbin. The cylinder becomes magnetized under the action of the current in the fixed coil; its magnetization being proportional to the strength of the current when sufficiently weak, and becoming reversed on the reversal of the current. The instrument is therefore eminently suitable for the measurement of weak alternating currents. The coil is wound in two parts, which may be used in series or in multiple arc, the resistance of each being about 250 ohms. A damping arrangement, similar to that employed in Thomson's quadrant electrometer, can be used. When the vibrations are not damped, speaking in a low voice into a Siemens telephone in connection with this instrument produces a deflection of 180mm. on a scale placed at the proper distance from a mirror which is attached to the iron cylinder. If one speaks at the distance of three or four metres from a microphone placed in the primary circuit of a small induction coil—the electrodynamometer being in the secondary circuit—a deflection of 48mm. is obtained. The price of the instrument is 225 or 240 francs, according as a concave, or a plane, mirror is supplied. A guard ring of soft iron can be supplied for twenty-two francs additional. The firm believe that the instrument will be of great use to physiologists. It is largely used in continental laboratories.

REPORTING lately to the Société d'Encouragement on the industrial preparation of carbonic acid in France, commenced by M. Gall, M. Troost points out that in Germany, which preceded France in this matter, what greatly stimulated the work was the consumption of beer, as it was found that by pressure of carbonic acid on beer, the latter could be brought up from cellars to bars in excellent condition, while compressed air spoiled the beer. In France, on the other hand, success has been due to the large quantities of salicylic acid used in medical treatment, this substance being largely produced by the reaction of liquid carbonic acid on sodium-phenol. The *Compagnie générale des produits antiseptiques* has works near Hermes (Oise), directed by M. Gall. Pure carbonic acid is there produced very economically by combustion of coke; is collected in a gasometer, from which it is drawn, to be dried and compressed with pressures of 5, 25, and 70 atmospheres, and stored in iron bottles. Most of the acid is used for making salicylic acid; but other applications occur, and M. Gall is increasing the power of manufacture. At present 300 kilogrammes are produced daily, but it will be possible ere long to produce 1000 kilogrammes. The liquid is now supplied in Paris at 60 c. the kilogramme (say 6d. for 2½ lbs.). Thus the French production is in a condition to compete with the German. Among other uses besides those already mentioned are the manufacture of aerated waters, the filtering of wine, cooling by virtue of the great absorption of heat in vaporizing, and solidification of fused metals under high pressure (which greatly improves the quality).

FROM a recent report on the telephone system in Belgium (which has grown rapidly since 1883) we learn that the State has considerably supplemented the work of the companies constructing and working various small lines, and using on all of them the double wire (while the companies have mainly continued the single one). The material used is the phosphorus bronze of Montefiore. The subscription varies largely, from 250 fr. in a radius of 3 km. in Brussels and Antwerp, to 125 fr. in Louvain and Malines. One interesting feature of the Belgium lines is that they are all connected with the principal telegraph offices, so that subscribers can send to these, by telephone, any telegrams they wish sent, and similarly they can receive telephonically any telegrams addressed to them. A copy of the telegram is sent at the same time. The number of telegrams thus sent by telephone in 1889 was 371,000; in 1890 it grew to 440,000. To facilitate the development of telephonic relations the country is divided by Government into a number of circles, containing several towns provided with central offices communicating with each other by means of a double wire. Thus the inhabitants of a small town like Heyst are able to speak with Bruges, Blankenburgh, Ostend, Middlekerke, and Nieuport. The system is being extended wherever clients are probable, and the telephone now enters largely into Belgian habits.

IN the south-east of the valley of Mont Dore (Puy-de-Dôme is a curious natural formation in the basalt, called the Creux-de-Souci. A crater-shaped depression about 80 ft. wide communicates by a central hole with a larger circular cavern, 170 ft. diameter, the bottom of which is occupied by a small lake with about 10 ft. of water. The shape is like that of two cups with bases opposed; the lower one the larger. From an examination of the place this summer by M. Martel and some friends (*La Nature*), it appears that carbonic acid is plentiful in the cavern. Several times they went down by rope-ladder, hoping to use a boat lowered previously; but they could not get below about 13 ft. from the water (which was about 70 ft. from the orifice); they experienced headache, progressive suffocation, &c., while matches and candles went out. The cavern is probably closed; there is no sign of a stream; nor are there any stalactites. The lake is merely fed by water filtering through the basalt; after heavy rain this is considerable. The temperature is exceptionally low, which M. Martel explains thus: Snow lies several months on the neighbouring ground, and when this melts in spring its water penetrates into the Creux-de-Souci at a temperature near 0°C. Thus the air is cooled, and, being denser than that outside it, accumulates below; it is not renewed from above. No air-current was observed. The accepted view that there is water communication with Lake Pavin (about 270 ft. lower) is considered a mistake. It would be interesting, M. Martel says, to make methodical observations, in different seasons, both as to the carbonic acid and the temperature.

MR. C. DAVIES SHERBORN asks us to state that the grant from the British Association, stated by us as being made towards "Index to Plants," &c., was really towards "Index Generum et Specierum Animalium," a work which has already been referred to on two occasions in NATURE—May 15, 1890, and July 2, 1891.

THE additions to the Zoological Society's Gardens during the past week include a Japanese Ape (*Macacus speciosus*, ♂) from Japan, presented by Mr. H. H. Jacobs; two Rhesus Monkeys (*Macacus rhesus*, ♂ ♀) from India, presented by Mr. R. Dodman and Mr. C. W. Emlyn respectively; a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Mr. R. Rocca; two Crowned Lemurs (*Lemur coronatus*) from Madagascar, purchased; a Common Cormorant (*Phalacrocorax carbo*), British, presented by Capt. Salvin; two Spotted-sided Finches *Amadina lathami*) from Australia, purchased; twenty-five Cambayan Turtle Doves (*Turtur senegalensis*) from East Africa, deposited by General Mathews; three Cambayan Turtle Doves (*Turtur senegalensis*) from East Africa, presented by General Mathews; three Hardwickes Mastigures (*Uromastix hardwicki*) from India, purchased; a Robben Island Snake (*Coronella phocarum*) from South Africa, presented by Miss M. Rutherford; a Nilotic Monitor (*Varanus niloticus*) from East Africa, presented by Gen. Mathews; a Nilotic Monitor (*Varanus niloticus*) from East Africa, presented by Mr. Frank Finn, F.Z.S.; two Smooth-clawed Frogs (*Xenopus lævis*) from East Africa, presented by Mr. Frank Finn, F.Z.S.; a Common Boa (*Boa constrictor*) from South America, presented by Messrs. F. Sander and Co.; four Indian Wild Swine (*Sus cristatus*), born in the menagerie.

OUR ASTRONOMICAL COLUMN.

NOVA AURIGÆ.—In *Wolsingham Observatory Circular*, No. 33, it is stated that Mr. H. Corder having informed the Rev. T. E. Espin that the Nova Aurigæ had increased, it was examined August 21, and found to be 9·2, spectrum monochromatic; one intense line (500?).

THE OPPOSITION OF MARS.—At the Lick Observatory, up to the middle of August, many of the supposed canals on Mars discovered in 1877 by Schiaparelli were mapped, but none of them seemed to be double. On the night of the 17th inst., however, Profs. Schaberle, Campbell, and Hussey made three entirely independent drawings, each showing the canal marked Ganges on Schiaparelli's map to be distinctly double, and thus confirming in 1892 Schiaparelli's discovery of 1877.

THERMAL ABSORPTION IN THE SOLAR ATMOSPHERE.—In *Astronomische Nachrichten*, Nos. 3105–06, Mr. E. B. Frost sets forth the results of his observations with reference to thermal absorption in the solar atmosphere. As the paper is of considerable length, we will only concern ourselves with the broad results, leaving our readers to look up the details for themselves. The instrument—made by Mr. Frost himself, and used throughout the experiments—was a double thermopile, or, rather, two thermopiles, of considerable length; and the back junctions, after being carefully insulated and imbedded in sealing-wax, were inserted in the two ends of a brass U-shaped tube, the front faces of the piles projecting a little out of the tube, while their back parts were in contact in the middle. To ensure an equality of temperature at the two back junctions, this part of the tube was enveloped in a cylinder filled with water, thus eliminating practically accidental thermo effects in the metals of the thermopiles. Mr. Frost's original intention was to employ both these piles, one for receiving the projected image of the sun, and the other for the direct rays, but, as he became acquainted with the "disproportionately greater intensity of the latter," he was obliged to employ as a screen a thin silk gauze, thus using this pile as a counterpoise to eliminate such effects as air currents, reflected radiations, &c.

Let us deal first with the photosphere. The following table shows the differences between observation and theory. The column headed O is obtained from a curve based on the observations, that of C is the result of theory and gives the values of $I : I_0$ as obtained from the ratio $\frac{I}{I_0} = \frac{e^{-f \sec \theta}}{e^{-f}}$. ρ represents the distance of the point observed from the centre of the sun (radius = 100), and θ the angle at the sun's centre between the line to the observer and the radius to the point observed.

ρ	θ	O	C	C–O
0	0	100·0	100·0	0·0
10	5·7	99·9	99·8	– 0·1
20	11·5	99·4	99·3	– 0·1
30	17·5	98·4	98·4	0·0
40	23·6	96·3	97·1	+ 0·8
50	30·0	93·6	95·1	+ 1·5
60	36·9	89·8	92·2	+ 2·4
70	44·4	84·6	87·8	+ 3·2
80	53·1	77·9	80·6	+ 2·5
90	64·2	68·0	65·6	– 2·4
100	90·0	(39)	—	—

The differences in the last column might, as Mr. Frost says, be somewhat reduced by the introduction of another constant in the formula, but even then sufficient difference would remain to indicate the inability of the formula to cope with the present conditions.

In the attempt to ascertain whether there was a difference in the thermal conditions for the poles and the equator, taking points equidistant from the centre of the sun's disc, the conclusion Mr. Frost draws is that there is none. The difference between the two hemispheres also he finds "to be exceeding small, if real." With regard to the spots he says, "A rather surprising result of these observations was that spots are occasionally relatively warmer than the surrounding photosphere." Whether the position of the spot on the disc had anything to do with it is uncertain, but where the observations were referred to it was found that "the two spots with the highest relative temperature were very near the sun's edge." He further suggests that if further observation should establish this fact, viz., that spots suffer less absorption than the neighbouring photosphere, we might consider them "to be in a higher stratum than the photosphere."

HYDROGEN SPECTRUM IN THE SOLAR ATMOSPHERE.—M. Deslandres, in the *Comptes Rendus* for July 25, communicates a brief note concerning the spectrum of hydrogen that was photographed by him in a prominence on the 4th of May last. This spectrum, besides containing many metallic lines, shows also ten ultra violet radiations of hydrogen and five other new ones, the latter of which, as he says, follow so regularly the former series that one is led to consider them as due to hydrogen. It may be remembered that Mr. Balmer indicated a simple function of whole numbers which represented exactly the series of 14 radiations of hydrogen. This function, which is applicable to most of the metals, is $N = A - \frac{B}{n^2}$ where N is the number of vibrations, A and B two constants, and n a whole number. In the following table we give the result of M. Deslandres' measures with regard to the new addition to this series, to show how close an agreement exists between the calculated and observed values :—

Whole Nos. of the formula n.	No. of vibrations		
	Deslandres.	Ames.	Calculated.
12	266·565	266·575	266·566
13	296·685	267·715	267·694
14	268·585	268·615	268·586
15	269·310	269·330	269·309
16	269·890	—	269·898
17	270·385	—	270·387
18	270·795	—	270·797
19	271·140	—	271·142
20	271·460	—	271·448
21	271·700	—	271·694

REFRACTION IN MICROMETRIC AND PHOTOGRAPHIC MEASURES.—A very simple method by which the effect of differential refraction may be eliminated from the results of micrometric observations or from the measures of photographic plates is given by Dr. S. C. Chandler in the *Astronomical Journal*, No. 271. The principle underlying this method is the position of the plate about to be measured, which here is inclined at a certain angle in the vertical direction to the focal plane of the telescope. In the measurement of distances this inclination necessitates the application of a small correction, but this is soon accomplished by the aid of a simple formula, which can be considerably modified by determining the screw revolution directly from the plate. One might at first think that by this means the stellar images would be slightly affected, but Dr. Chandler informs us that he thinks that "attentive examination will show that the difference of definition will be inappreciable."

THE RECENT EARTHQUAKES.

THE first of the earthquake shocks felt on the 18th inst. in Ireland, Wales, and the West of England was evidently one of unusual strength for this country, and it is very desirable that both it and the subsequent slighter shocks should be thoroughly investigated, with a view to discovering their origin and their relations to one another. As I have been engaged for several years in working at our British earthquakes, and am now occupied in studying these recent shocks, I should be greatly obliged if you would allow me to ask your readers who felt the shocks for assistance in obtaining the necessary materials.

It would be of great service to know simply the names of as many places as possible where one or more of the shocks were felt and the accompanying sounds heard. With this knowledge the boundaries of the disturbed area and the sound-area of each shock may be determined—points of considerable importance. But for a complete study of the shock it is desirable to have further details, such as would be given by answers to the questions printed below, especially to those numbered 3, 4, 6, and 7. I shall be most glad and thankful to receive accounts of the earthquakes from any place whatever, and I may add that no account, however scanty the information given, can fail to possess some value or to help in throwing light on the nature and origin of the shock.

(NOTE.—If more than one shock was felt it is important that the notes relating to each should be kept separate.)

(1) Name of place where the shock was felt.

(2) Situation of the observer: (*a*) Whether indoors (and on which floor of the house) or in open air: (*b*) How occupied at the moment of the shock.

(3) Time at which the shock was felt, if possible, to the nearest minute.

(4) Nature of the shock, description of the: (*a*) The number of vibrations: (*b*) Their relative intensity: (*c*) Whether there was any tremulous motion before or after the principal vibrations: (*d*) Whether any vertical motion was perceptible, and if so, whether the movement was first upward and then downward, or first downward and then upward.

(5) Duration of the shock in seconds, not including that of the accompanying sound.

(6) Intensity of shock: Was it strong enough (*a*) to make windows, doors, fire-irons, &c., rattle: (*b*) To cause the chair or bed on which the observer was resting to be perceptibly raised or moved: (*c*) To make chandeliers, pictures, &c., swing, or to stop clocks: (*d*) To overthrow ornaments, vases, &c., or cause plaster to fall from the ceiling: (*e*) To throw down chimneys, or make cracks in the walls of buildings?

(7) Sound-phenomena: (*a*) If any unusual rumbling sound was heard at the time of the shock, what did it resemble? (*b*) Did the beginning of the sound precede, coincide with, or follow, the beginning of the shock, and by how many seconds? (*c*) Did the end of the sound precede, coincide with, or follow, the end of the shock, and by how many seconds? (*d*) Did the sound become gradually louder and then die away? (*e*) Were the principal vibrations felt before, at, or after the instant when the sound was loudest?

(8) The names of any other places where the earthquake was noticed would be most useful, together with answers for each place (if possible) to the following questions:—(*a*) Was the shock felt? (*b*) Was it strong enough to make doors, windows, fire-irons, &c., rattle? (*c*) Was any unusual rumbling sound heard at the time of the shock? CHARLES DAVISON.

38, Charlotte Road, Birmingham, August 23.

CHEMISTRY AT THE BRITISH ASSOCIATION.

AFTER the President's address, the first paper was read by Prof. Crum Brown on "Electrolytic Synthesis," descriptive of work carried out in conjunction with Dr. J. Walker.

He showed how, by an extension of the electrolytic methods which had been already fully worked out in relation to potassium acetate, the higher fatty acids of other series could be synthesised. Thus, starting from the ethyl potassium malonate the ether of succinic acid was obtained in considerable quantity and with great readiness. Similarly adipic, sebacic and other ethers had been obtained. Secondary products were formed which in the higher members of the series accumulated in inconveniently large quantities.

Professor Ramsay gave a communication on the "Impurities in Chloroform." He found that when the purest chloroform that could be prepared was exposed to light between the months of March and July, it emitted an acrid odour when opened, due to the formation of phosgene gas. The reaction by which this had been brought about was :—

$$2CHCl_3 + O_2 = 2\ COCl_2 + 2\ HCl.$$

The second day of the meeting was devoted almost entirely to the consideration of the phenomena accompanying the combustion of gases. Messrs. Lean and Bone gave an account of the results obtained in exploding ethylene with less than its own volume of oxygen. They had found that there was always a considerable rise of pressure, and that the resulting products contained, in addition to hydrogen and carbon monoxide, small percentages of carbon dioxide, unsaturated hydrocarbons, and some saturated hydrocarbon, presumably marsh gas.

The unsaturated hydrocarbons consisted largely, if not entirely, of acetylene. Carbon is also formed as a product of the reaction, due in all probability to the decomposition of heavy hydrocarbons into marsh gas and carbon at high temperatures. The experiments show that oxygen combines with carbon in preference to hydrogen.

Prof. Lewes, in his paper on the "Luminosity of Hydrocarbon Flames," described the results of the analyses of the gases drawn from an ordinary coal gas flame at different heights. He had found that the heavy hydrocarbons which occur in the non-luminous part of the flame are almost entirely converted into acetylene before they reach the luminous zone. The luminosity of the flame is, in his opinion, brought about by dissociation of the acetylene, the temperature required for this dissociation varing with the degree of dilution of the acetylene. Under the circumstances already described, where the amount of acetylene present was 1·1 to 1·3 per cent., the temperature was 1200°, whilst in the flame of a paraffin lamp, where about double the amount of acetylene was present, the temperature was found to be 1000°.

On passing ethylene through a heated tube at different temperatures he found that at 900° the chief products were methane and acetylene; at 1000° there was still no hydrogen and no carbon, but more oil and heavy hydrocarbons, whilst at a still higher temperature hydrogen and carbon appeared amongst the products; above 1200° there was much carbon and little or no hydrocarbons. The actual temperature of the gas flame used was 500° at a distance of half an inch above the burner; 1279° at the top of the non-luminous zone, and 1370° at the top of the luminous zone.

Prof. Smithells followed with a number of very beautiful "Experiments on Flame." He held that the ordinary candle flame showed four and not three zones as usually described. He considered that the phenomena of combustion in flames ought to be studied by using gases of simple and definite composition rather than a variable and complex mixture such as coal gas.

He showed, by means of experiments, the two distinct zones in the non-luminous Bunsen flame, and how these could be separated, and their character varied according to the amount of air admitted, and similar illustrations were given by burning a jet of air laden with benzene vapour. Under the conditions of the Bunsen flame he had found that whatever hydrocarbon was used the products withdrawn from the inner cone consisted of carbon monoxide, carbon dioxide, hydrogen, and water vapour, whilst in the case of the benzene flame described, when the air supply was so regulated as to produce a luminous zone between the inner and outer zones, acetylene was found amongst the gases withdrawn from that zone.

His experiments had led him to conclude that when the hydrocarbon is starved of oxygen the carbon burns preferentially to the hydrogen.

Prof. Smithells then introduced a spray of cupric chloride solution into the gas, and showed that the inner flame remained unaltered in appearance, whilst the outer flame became green.

He is of opinion that the decomposition of the salt takes place in the inner flame, and that the colouration of the outer flame is due to the projection of the products of decomposition through the outer flame. A discussion followed these papers, in which Sir G. G. Stokes described the experiments he had performed with a view to determine whether the luminosity of the flame was due to carbon or to hydrocarbons. He was not in favour of the idea that the colouration of the flame was due to chemical reactions taking place within it. Sir Henry Roscoe thought it due to the separation of metal in the flame, and not to the oxide. Prof. Liveing quoted the results of his observations on the spectrum of oxygen, and expressed his adherence to the hydrocarbon theory of luminosity. Prof. Ramsay supported Prof. Smithells' contention. The discussion came to a conclusion with the replies of the authors of the papers.

Dr. J. A. Harker then followed with a description of "The Reaction of Hydrogen with Mixtures of Hydrogen and Chlorine." He finds that as had been previously observed by Horstmann, Bunsen, and others, the hydrogen combines partly with the oxygen and partly with the chlorine, but that the reaction varies with the quantities of the constituent gases present, and takes place in accordance with the law of Guldberg and Waage.

Prof. Clowes gave the results of the investigations which he had taken up in order to produce a safety lamp which should indicate with greater accuracy the presence of inflammable gases and vapours in air. In confirmation of previous observations he had found hydrogen to be by far the most sensitive flame, and he described a means by which hydrogen could be burnt in an ordinary oil safety lamp with greater convenience than had hitherto been possible.

A discussion which was to have been held in conjunction with Section D on the "Chemical Aspects of Bacteriology," fell through.

Prof. Roberts Austen gave a paper on the "Effect of Small Quantities of Foreign Matter on the Properties of Metals." The addition of two-tenths per cent. of lead or bismuth to gold was found to render it quite brittle, whilst extremely small quantities of phosphorus, magnesium, and zinc made nickel malleable. Such phenomena had no doubt been of great interest in ancient times to the alchemist, but to-day they constituted all-important questions for the engineer. Experimenting on gold, which could be obtained more readily than most other metals free from impurities, either solid or gaseous, he found that the tenacity was decreased by the addition of small quantities of elements whose atomic volumes were greater than that of gold, whilst those elements whose atomic volume was the same or smaller than that of gold, increased its tenacity. Lithium and aluminium acted in an exceptional manner. Furthermore, whilst the addition of 10 per cent. of aluminium gave an alloy melting at 400° lower than gold, 23 per cent. of the admixture yielded a brilliant alloy having a higher melting point than gold. He pointed out also that gold during the process of cooling showed abnormalities similar to those shown by iron, which, however, disappeared when the operation was carried out under pressure. Prof. Hartley had found that iron required to be slightly oxidised before it could be melted, even at a temperature which sufficed to melt platinum. He had always found that silver and copper, unless prepared with special precautions which he described, contained gold.

Dr. Gladstone submitted a communication on the "Molecular Refraction and Dispersion of Metallic Carbonyls and of Indium, Gallium and Sulphur." The observations made on a sample of the iron pentacarbonyl supplied to him by Mond indicated an extreme dispersion for iron, even taking the highest value for carbonyl previously recorded. He attributed, however, a still higher value (11·2) to carbonyl, and assigned a chemical formula in accordance therewith. With regard to sulphur he had found that the values obtained varied only slightly, whether the sulphur was in the liquid, solid or gaseous condition. Prof. Liveing found that the same thing held for oxygen and nitrous oxide in the liquid and gaseous conditions, and considered that this pointed to the continuity of the gaseous and liquid states.

Dr. G. H. Bailey gave a paper on "Impurities of Town Air." He pointed out that the amount of air taken into the system daily greatly exceeded that of the liquid and solid food, whilst according to Tyndall expired air was very free indeed from solid particles, and that air was undoubtedly the medium by which many diseases were propagated, and that in towns, as a matter of fact, the death-rate rose to very abnormal proportions during those periods when the air was most polluted. Under these circumstances it was a matter of surprise that so little attention had been devoted in recent years to the determination of the impurities in air. A very large amount of information had, it was true, been obtained relating to the carbonic acid in air, and this had led to valuable results; but with the exception of Dr. Russell's extremely interesting reports, hardly anything had been done in the direction of determining the sulphurous acid and organic matter with which town air, especially at certain seasons, was laden. He then described the methods which had been adopted by the Air Analysis Committee of Manchester for determining these impurities, showing how it was not only possible to arrive at a measure of the amount of suspended organic matter, but also to ascertain proximately how far it was of a noxious character. Such analyses may appropriately be supplemented by a bacteriological examination of air. Some hundreds of analyses of the air of London, Manchester, and Liverpool had been made, and the following conclusions were drawn from them:—(1) That in clear breezy weather the amount of sulphurous acid in town air does not exceed one milliogramme per 100 cubic feet of air. (2) That in antiyclonic periods, and especially in times of fog, diffusion is seriously interfered with, and the quantity has been found as high as 50 milligrammes. (3) That the organic impurities in air also increase under similar conditions to those which promote the accumulation of sulphurous acid to 40 or 50 times their normal amount at least.

In the discussion which followed Sir Douglas Galton expressed himself well satisfied with the enquiry, and hoped that the work would be continued. He called attention to the tendency for decaying matter to collect, especially in certain areas of large towns and the danger of allowing such accumulations. Mr. A. E. Fletcher, Chief Inspector of Alkali Works thought the house fire was a large contributor to the evil and a most difficult one to contend against. He suggested filtering the air for the house through cotton wool filters and had found that it could be applied with great success. Mr. Warrington criticised the methods of analysis and would like to see the determinations extended so as to show in what quantity the respective sulphur compounds existed in the air. Dr. Rideal had found the method of determining sulphurous acid most reliable and preferable to the Gas Referee's test used for the estimation of sulphur in coal gas. Messrs. Hartog, Fairley, Thomas, Dr. Clowes and the President also spoke on the paper, and Dr. Bailey replied to various points which had come up in the discussion.

Subsequently, Prof. W. H. Perkin described methods of synthesis with the aid of butane and pentane tetra-carboxylic ethers the constitution of the methylene ring compounds being illustrated by Prof. Crum Brown by means of a very ingenious set of models.

A number of papers were carried over to the last day of the meeting mainly dealing with atomic weights and analytical work. Amongst these. Prof. Ramsay and Miss Aston contributed the atomic weight of boron (*a*) by determination of the water of crystallization in borax (*b*) by conversion of anhydrous sodium borate into sodium chloride. The value obtained was 10·966. Mr. Hartog drew attention to the results just published of a determination of the atomic weight of boron by the late Dr. Abrahall.

Prof. Ostwald read a communication on the assumed potential difference between metals in the solid and in the molten state. His experiments failed to detect any such difference of potential; it is at any rate below $\frac{1}{1000}$ of a volt. Prof. McLeod showed that the iodides of sulphur, SI_6 and S_2I_2, if they existed at all as chemical compounds, were of a most unstable nature; the only evidence of definite combination having taken place in S_2I_2 was that it melted at a lower temperature than either of its constituents.

BIOLOGY AT THE BRITISH ASSOCIATION.

SO many important and interesting papers were submitted to the Organizing Committee of D this year that it was found necessary to divide the section into the three departments of Zoology, Botany, and Physiology. The plan of adjourning for lunch at half-past one, and resuming work again at two, with some attractive papers for the afternoon, was tried and found a success. Practical demonstrations and exhibitions were also given in the afternoons in the laboratories above the lecture-room.

On Thursday, August 4, after the president's address, the following series of reports by committees appointed at the Cardiff meeting was submitted: (1) The Zoology and Botany of the West India Islands; (2) the Naples Zoological Station; (3) Zoology of the Sandwich Islands; (4) Botanical Laboratory at Ceylon; (5) Migration of Birds; (6) Plymouth Laboratory; (7) Deep-Sea Tow-net; (8) Protection of Wild Birds' Eggs. All of these committees have this year been re-appointed with or without grants. Three papers were then taken in the afternoon, viz.: (1) Renewed experiments on the modification of the colours of Lepidopterous larvæ, with exhibition of specimens, by E. B. Poulton, F.R.S.; (2) Prof. Preyer, of Berlin, on the physiology of protoplasm; and (3) Prof. Hartog on the alleged personality of the segments of the nucleus, and Weismann's "Idant" theory of heredity. Prof. Preyer attributed an important part to the absorption of oxygen by the protoplasm in the formation of pseudopodia. Prof. Hartog contended, from previously ascertained facts, and from his own recent researches, that the view that the segments that constitute the young nucleus persist during its maturity is untenable, and that Weismann's "Idant" theory of heredity being founded thereon must necessarily fail.

On Friday, in the Botanical Department, important papers were read by Dr. Scott (on Secondary Tissues in Monocotyledons), Prof. Goebel (on the Simplest Form of Mosses), Prof. Errera (Physiological Action at a Distance), Prof. Bower (Morphology of Spore-bearing Members in Vascular Cryptogams), and others; these will be noticed elsewhere.

In the Department of Physiology there were the following:—

(1) Prof. Waymouth Reid gave a paper on Vital Absorption, in which he showed that the older views of Dutrochet and others as to the process being a physical one due to osmosis must be modified in the direction of showing that the vital activity of the cells composing the absorbing membrane must be taken into account. We know that changes are wrought upon substances during the process of absorption, such as the regeneration of serum-albumen from peptone. In the case of the intestine of the rabbit in full digestive activity, one can get evidence of a stream passing from within outwards so long as the tissues are alive. Scraping off the epithelium diminishes the transfer or puts a stop to it. By the addition of pilocarpine to the fluids used, it is possible to reverse the direction of the stream.

(2) Prof. Rosenthal, of Erlangen, read a paper on Animal Heat and Physiological Calorimetry. The apparatus he made use of has an air calorimeter. In fever, produced by injection of putrid matter, he finds that heat production is not augmented; although in a few experiments he made on man he found a small augmentation of heat production.

(3) Dr. Lockhart Gillespie communicated a paper on Proteid-hydrochlorides, in which he stated that all proteids have an affinity for hydrochlorides, and the lower proteids combine with a greater percentage of HCl than the higher. These results were supported by the amount of silver which is contained in a series of the different proteid salts of silver, the ratio of silver to albumen being highest, and that of silver to peptone being lowest. The different stages of gastric digestion of a meal he finds to be:—1, the amylolytic stage—no free HCl being present, but some combined proteids—duration about ten minutes; 2, combined hydrochloric acid (proteid-hydrochloride)—acidity considerable, no free HCl, small amount of lactic acid present—duration about half an hour; 3, free HCl stage—some free HCl, but mostly combined, lactic acid disappearing; 4, the chief absorption stage—acidity falling, but proportion of free to combined HCl rising—from three to four or five hours; 5, evacuation—propulsion of contents of stomach into duodenum at fourth or fifth hour.

(4) Dr. E. W. Carlier gave an account of the hibernating gland of the hedgehog, which is situated along the cervico-dorsal and in the axillary regions, and attains its maximum dimensions in October—*i.e.*, just at the commencement of hibernation—and its minimum shortly after the animal has awakened from winter sleep. Histological examination shows that towards the close of hibernation many of the cells change. The chromation in the nucleus diminishes, the fat stored in the cell gradually disappears, and finally the whole cell breaks up. Dr. Carlier considers that the hibernating gland is not merely a storehouse for fatty matter, but actually secretes some nutritive material of great service to the animal during its winter sleep.

(5) Dr. G. Mann read a paper on the Functions, Staining Reactions, and Structures of Nuclei, in which he endeavoured to prove that the achromatic elements of a cell are the most important, and that the nuclear chromosomes are organs for the assimilation of food, while the centrosome is a trophic centre for the nucleus.

In the Department of Zoology, the following papers were read:—

(1) Dr. Henry C. McCook (Philadelphia), on the Social Habits of Spiders. This paper considered the claims of certain species of the Araneæ to possess in some degree the communal tendencies of the Social Hymenoptera. The eminent French araneologist, M. Eugène Simon, in his studies of South American spiders, finds a temporary sodality among certain orb-weavers (*Epeira Badelieri*) at the cocooning season, which Dr. McCook thought might be explained by the well-known fact that female spiders when cocooning often choose the same locality and mass their egg-bags, the one mother overlaying the cocoon of another. But this is quite incidental, and occurs with species which are known to be solitary. The close grouping of Simon's *Uloborus republicanus* was regarded as no proof of a sodality, but simply showed an assemblage of snares in proximity which is not uncommon. The gathering of males in groups on the outer lines of the webs is quite what one sees in other species with which there is no departure from the solitary habit. The third example of supposed social spiders (*Anelosimus socialis*) shows characteristics closely resembling those of young spiders of various genera, who will weave around themselves upon the foliage where they lodge a tent of delicate spinning work within which they dwell for a short space, and then scatter, every individual at once assuming the solitary habit. If Simon's observations be here confirmed, we shall have the transfer of this trait of young spiders in many species to the adult period of at least one species. The fact

would revolutionize our ideas of the universal prevalence of the solitary habit. The paper was illustrated with a number of large painted figures.

(2) Prof. A. Crum Brown, F.R.S., on a Use of the External Ear. The form of the external ear enables us to find the altitude of the source of sound by rotating the head about a horizontal right and left axis.

(3) Prof. Lloyd Morgan, the Method of Comparative Psychology. The object of this communication was to show that our interpretation of animal intelligence is necessarily based on a double or two-fold process of observation: 1st, the activities of animals have to be carefully observed as objective phenomena; 2nd, our own mental processes have to be carefully observed and cautious inductions drawn from them. Finally the objective phenomena reached by the first process have to be interpreted in terms of conclusions obtained through the second. In the higher animals there is abundant evidence of ability to sense or feel relations, but little or none of the perception or cognition of the relations of introspection or of reflection, and possibly herein we have a limit to animal intelligence.

(4) Mr. J. E. S Moore, on the Relationships and Rôle of the Archoplasmic Body during Mitosis in the larval Salamander. The author has extended the discovery of the archoplasmic body in the spermatocyte of the salamander to the somatic cells of both the larva and adult, and especially to the cells of the germinal blastema and the leucocytes. He demonstrated for this vertebrate a distribution and functional activity of the archoplasmic body identical with that recorded by Platner for the invertebrate *Helix*; and concluded that the archoplasmic body is the sole agent in the formation of the achromatin spindle-fibres.

(5) Prof. J. C. Stewart exhibited with remarks an abnormal fore foot of a horse, in which two large digits and vestiges of others were present.

(6) Dr. G. Mann read a paper on the Origin of Sex, in which he contended that any sexual cell might be transformed into either a male or female cell, according to the facilities of acquiring and assimilating food material.

(7) Dr. J. Beard, on Larvæ and their Relations to Adult Forms. The author attempted to show that all metazoa above cœlenterata developed through the intermediation of a larva (often disguised by the presence of food yolk), and, in fact, upon the latter. He urged that the recapitulation theory was no explanation of the phenomena of embryology; at best it held good to a limited extent for the ontogeny of certain organs. The views of the author led him to regard metazoon development as a sort of alternation of generations.

(8) Professor W. A. Herdman, F.R.S., on the Exploration of the Irish Sea to the south of the Isle of Man now being carried on by the Liverpool Marine Biology Committee.

On Saturday, August 6th, the section did not break up into departments. The following papers were read:—

(1) Prof. McKendrick, F.R.S., demonstrated by means of a new form of myograph a method of recording and projecting simultaneously upon a screen, through the aid of lime light, curves of muscular contraction. He also showed a method of measuring and recording the time occupied by short voluntary movements, such as those of the fingers in writing, or the movements of the tongue.

(2) Prof. G. Fritsch (Berlin), on the Origin of the Electric Nerves in the *Torpedo*, *Gymnotus*, *Mormyrus*, and *Malapterurus*. Prof. Fritsch pointed out that there are two kinds of electric organs found, the one being modified muscles, as is the case in *Torpedo*, *Gymnotus*, *Mormyrus*, and *Raia*, while the other belongs to the cutaneous system, and is probably transformed gland cells of the skin, as in *Malapterurus*. In electric organs originating from muscles there are many ganglion cells, but in those derived from skin organs there are only two ganglionic cells, one on each side, and only one nerve fibre belonging to each cell, which fibre is formed by a combination of protoplasm-processes at a certain distance from the gigantic ganglion cell.

(3) Prof. Miall, F.R.S, gave an account of the leaf of the water plant *Victoria regia*, illustrated by lantern slides, in which he described the peculiarities of its structure, and the way in which it is modified to suit its special environmental conditions.

(4) Dr. J. Musgrove, the Blood-vessels and Lymphatics of the Retina. The author pointed out that the distribution of the vessels in the retina was as regular as that occurring in the arm or the leg. The blood-vessels of the retina of the ox may be divided into three sets. There are upper and lower sets of branches of large vessels, and there is an intermediate zone entirely free from large vessels except in so far as it is traversed by the main stems of artery and vein in their course to the upper part of the retina. This intermediate zone the author regards as the homologue of the yellow spot found in the human retina. The capillary vessels on a transverse section of the retina are seen to lie chiefly in the nerve cell layer, the inner molecular layer, and the inner nuclear layer. Only rarely are capillaries found beyond the inner nuclear layer, and they never extend as far as the outer nuclear layer, so that the outer layers (the rods and cones, &c.) are entirely free from vessels.

(5) Mr. H. O. Forbes exhibited a recently discovered series of sub-fossil bones of extinct birds of New Zealand and the Chatham Islands, and made remarks upon the localities where they had been found and upon their distribution. From the Chatham Islands the specimens were in a remarkably fine state of preservation, and included the species described under the names of *Aphanapteryx hawkinsi*, *Fulica newtoni*, and *Corvus moriorum*, along with portions of *Nestor* and *Harpa*. From New Zealand, *Bizuira*, *Cereopsis*, *Cygnus*, and the type specimens of *Cnemiornis gracilis*, Forb., were exhibited, and also the larger part of the skull of *Harpagornis moorei*, Haast.

(6) Dr. J. Clark, on the Natural Relations between Temperature and Protoplasmic M ovements. The author showed that the minimum temperature for protoplasmic movements depended on the nature, habits, and natural surroundings of the plants, and that change of conditions of growth induced change of minimum.

(7) Dr. J. Clark, Experimental Observations on the Functions of the Nucleus in the Vegetable Cell. By divesting the vegetable cell of its wall, and also by mechanically separating the protoplasmic contents of a cell into two equal parts, the author tried to show the relations between the nucleus and cell-wall formation, and between mechanical stimulus and nuclear activity.

(8) Dr. Francis Warner, Co-ordination of Cellular Growth and Action by Physical Forces. The facts accumulated in a report on 50,000 children observed by the author appear to show that defects in development of the body are largely co-related with defects of the nerve system in its power of co-ordination and mental function.

(9) M. Louis Olivier, La Canalisation des Cellules et la Continuité de la Matière vivante chez les Végétaux et les Animaux. The author has for some time recognized, even in highly differentiated tissues, the canalization of the cell wall and the free passage of protoplasm; and lately he has obtained evidence, photographic and otherwise, that in highly organized forms, such as Dicotyledons, the protoplasm is continuous from the extremity of the roots to the tips of the leaves.

(10) Dr. John H. Wilson, some Albucas and their Hybrids. The author has formed crosses between hybrids and the parent forms in several species of the African liliaceous genus *Albuca*.

On Monday, Section D was occupied in the forenoon by a discussion on "Sea-Fisheries":—

(1) Prof. McIntosh, F.R.S., opened the discussion by a paper entitled "A Sketch of the Scotch Fisheries, chiefly in their scientific aspects, during the past decade, 1882-92," in which he gave an interesting account of the condition of the fisheries, and of the investigations which have been carried on by the Fishery Board of Scotland, and at the St. Andrews Marine Laboratory, and elsewhere.

(2) Prof. Ewart followed with a general paper on our sea-fisheries, in which he showed that some of our valuable fishes are becoming scarce, and discussed various remedial measures which have been suggested. He considered that fish-hatching was not of much practical use if the young were merely returned to the sea when hatched.

(3) Mr. E. W. L. Holt read a paper, drawn up by himself and Messrs. W. L. Calderwood and J. T. Cunningham, of the Marine Biological Association, on the Destruction of Immature Fish, and a discussion of remedial measures. In this paper the authors dealt chiefly with the protection of immature fish by the imposition of a size limit. It was contended that the size limits proposed at the conference at Fishmongers' Hall last February are altogether too small, and that no limit can be useful which is not based upon the size at which a fish is for the first time able to reproduce its species. Tables were given showing the variation which exists in this respect in the different districts. The authors gave figures showing the immense destruction of immature fish on certain grounds lying on the east side of the North Sea, and the opinion was expressed by Mr. Holt, who has had

charge of the Association's work in that district, that the imposition of a reasonable size-limit for plaice alone would do more to cause the trawlers to leave these grounds unmolested than could be effected by any scheme of closing based on international agreement.

Various zoologists and fishing experts, including Prof. Ray Lankester, Prof. McIntosh, Prof. Ewart, Dr. Fullerton, Mr. Olsen, Mr. Stebbing, Mr. Walker, and Prof. McKendrick, took part in the discussion which followed.

(4) Dr. W. Ramsay Smith, The Food of Fishes. This statistical paper gives the result of observations made by the naturalists of the Fishery Board for Scotland on over 10,000 food fishes collected in the Firth of Forth and St. Andrews Bay during the last four years. The author considers the statistics so extensive as to reduce the limit of the errors of observation to such an extent as to allow general conclusions of a trustworthy character to be drawn now for the first time.

(5) Mr. E. W. L. Holt, Notes on Teleostean Development.

(6) Mr. A. P. Swan, The Effect of Sea-water on the Vitality of the Salmon Fungus. The author showed that immersion in sea water even diluted with any lesser proportion than three parts of fresh water is fatal to the fungus; and from the continuous nature of the hyphæ it is certain that the disease is destroyed on the stay of the fish in the sea, and that the recurrence of the disease on the return to fresh water must be due to re-infection. In the discussion that followed Mr. George Murray expressed his acceptance of the author's results.

(7) Prof. E. G. Prince, on the Formation of Argenteous Matter in the Integument of Teleosteans. The fibrillated substance to which the integument of many fishes owes its silvery lustre is formed in a layer of granular plasma which belongs to the mesoderm.

(8) Prof. E. E. Prince, The Development of the Pharyngeal Teeth in the Labridæ. The grinding plates in the pharynx of wrasses are developed from rounded dental sacs formed from the cells of the mucous layer.

(9) Dr. Carlier, on the Skin of the Hedgehog. The skin of the dorsal surface is very thick, and very rugose. The spines spring from depressions between the rugosities. On section the mucosa is very thick, and devoid of blood vessels except beneath. Sweat and sebaceous glands are absent: radiation of heat is thereby almost prevented. The spines which are morphologically hairs, are fixed in the cutis vera by a broad base, near which is a rich capillary plexus. The spines, consist of cuticle, cortex, and medulla. The cortex is strengthened internally by twenty-two or more longitudinal septa. The medulla is divided into loculi by transverse imperforate septa, which divide at their margins into secondary septa, which again divide into tertiary, enclosing respectively secondary and tertiary loculi. The erector pili is very large, and somewhat fan-shaped. The skin of the ventral surface is much thinner, and is covered with soft hairs between which and the spines there is a gradual transition on the flanks. Sebaceous and sweat glands are present, and also much adipose tissue, and a thin skin muscle.

(10) Rev. Alex. S. Wilson, on the Industry and Intelligence of Insects in relation to Flowers.

(11) The following demonstrations were also given:—Dividing Pollen Mother Cells, by Prof. M. Hartog; Hibernating Gland of Hedgehog, by Dr. Carlier; Variations in Arrangement of Feathers in Wings of Birds, by Mr. Goodchild; Embryo-sac of Angiosperms, by Dr. G. Mann.

On Tuesday, Aug. 9, the Section again separated into Departments. In the Botanical Department, papers were read by Prof. Schmitz (Knöllchen am Thallus einiger Florideen), Mr. Carruthers (on the Structure of the Stem of a typical Sigillaria), Mr. T. Hick (on Calamostachys Binneyana), Mr. A. C. Seward (on Myeloxylon from Millstone Grit and Coal Measures), Prof. Hillhouse (Disappearance of native Plants from their local Habitats), and others which will be noticed elsewhere.

Mr. G. Murray drew attention to a comparison of the Marine Floras of the warm Atlantic and Indian Ocean, his remarks being illustrated by a printed table of statistics. He dealt with the question whether since the last period of a warm climate at the Cape when the two tropical marine floras mingled, the genera and species had had time to vary much, or remained the same in the warm Atlantic and Indian Oceans now separated by the colder flora at the Cape.

Mr. Harold Wager read a paper on the Structure of *Cystopus candidus*, a fungus found parasitic on the shepherd's purse. He pointed out that the nuclei are similar in structure in many respects to the nuclei of higher plants. In the formation of the oospore a number of nuclei are restricted to the periplasm, and at a late stage a number of nuclei are found in the oospore surrounding a large central oil globule. During fertilization the protoplasm and nuclei contained in the antheridium pass over into the fertilizing tube, but whether any of the contents pass into the oospore was not determined.

A paper, by Mr. James Britten, was read protesting against certain proposed changes in Botanical nomenclature.

Two papers were given by Prof. G. Gilson (Louvain), on the Affinity of Nuclein for Iron and other substances, and a Method of Staining Nuclei by Chemical Means. It is now certain that dead nuclein, as well as other substances found in the cell, have a strong affinity for the various compounds of iron and of other metals and negative chemical bodies. Thus the difficult question arises, Is the presence of iron in the nuclear elements constant and normal during life, and is this metal necessary for the chemical activity of the nucleus?

Dr. C. H. Bailey, Manchester, discussed the conditions affecting plant life in a town atmosphere, especially the falling off in the amount of light received, and the increase in sulphurous acid. Finally, a paper was read by Dr. G. Mann, which contended that the view first put on record by the author, viz., that the embryo-sac of Angiosperms corresponded to a sporocyte, and not a macrospore, was confirmed by the observations of Guignard, Dodel, and Overton, and that the eight cells within the embryo-sac were eight female sexual cells corresponding to the eight male sexual cells derived from a pollen mother-cell.

In the Department of Zoology the following papers were read:—

(1) Baron Jules de Guerne, Présentation de Planches inédites de Zoologie concernant les Recherches du Yacht *l'Hirondelle*.

(2) Baron Jules de Guerne, Crustacés Copepodes des Eaux sursaturés de Sel de la France et des Canaries.

(3) Dr. Arthur Robinson, Observations on the Development of the Posterior Cranial and Anterior Spinal Nerves in Mammals. At an early stage (eleven protovertebral somites) a continuous cord of nerve cells extends backwards from just within the posterior part of the auditory depression along the dorso-lateral angle of the medulle and spinal cord. At the time of formation of the secondary optic-cup this cellular cord loses a connection it had with the dorsal extremity of the neural tube, thickens between auditory vesicle and first somite, remains relatively small from first to fourth somite, and beyond the fourth somite gives origin to a series of swellings, the spinal ganglia. The ganglionic enlargement in the presomitic region becomes the root-ganglia of the glosso-pharyngeal and vagus nerves. An enlargement in relation with the fourth somite becomes the first cervical ganglion. Other enlargements in second and third somites become connected either with spinal accessory or (in cat) with posterior root of hypoglossal nerve.

(4) Prof. J. C. Ewart, on the Cranial Ganglia. The author discussed chiefly the ganglia of the glossopharyngeal and facial nerves in elasmobranch fishes, and their relations to the branches of the cranial nerves.

(5) Prof. W. A. Herdman, F.R.S., gave two short notes, one on the Geographical Distribution of Ascidians, in which he drew attention to the great predominance of species and individuals, and also of gigantic specimens in Arctic and in Antarctic seas; the other on the Presence of Atrial Tentacles in various genera of Tunicata, with a suggestion as to their function. The various forms in which up to now atrial tentacles have been found are phylogenetically rather closely related, and most of them are species in which the animals are in the habit of living closely aggregated together. Possibly under these crowded conditions it is an advantage to the animals to have the power (as some have) of reversing the usual current of water, or of using the atrial for a time as the inhalent aperture, when the atrial tentacles would have important functions to perform.

(6) Mr. E. B. Poulton, F.R.S., gave two interesting exhibitions of series of specimens, the one illustrating renewed experiments on the modifications of the colours of Lepidopterous pupæ, and the other being an observation bearing on the non-transmission of characters acquired by certain pupæ.

(7) Dr. J. Symington, on the Cerebral Commissures in the Marsupialia and Monotremata. The author held that in these two divisions of the Mammalia the Corpus Callosum was absent, the only transverse fibres that exist being those known as the

hippocampal commissure and the anterior commissure. These results support the conclusions of Owen, and are opposed to those of Flower.

(8) Prof. J. Playfair McMurrich, the Early Development of the Isopods. The author described the structure and mode of segmentation of the typical centrolecithal ovum of the Isopod *Jæra*, calling attention to the early differentiation of the germ layers, which may be traced back to the eight-celled stage. The mesoderm forms at first a band of cells surrounding the embryo, and later concentrates towards the ventral surface to form the blastodisc, behind which is the endoderm, these two layers becoming later enclosed by the ectoderm, which grows back over them by teloblastic proliferation.

(9) Dr. J. Beard gave some notes on Lampreys and Hagfishes.

(10) Prof. G. B. Howes and Mr. J. Harrison, on the Skeleton and Teeth of the Australian Dugong. The authors described the process of vertebral-epiphysis formation, showing that epiphyses, so far as represented, are formed late, and are rapidly merged into the substance of the vertebral body. They described the formation of structures which might, perhaps, be regarded as anticipatory of supernumerary phalanges, and pointed out that their observations lent no support to Kukenthal's view of the epiphysial nature of such phalanges. Five mandibular teeth were found to be present in the anterior region of each ramus in the manatee, and one of these they claimed as a canine. They recorded the discovery of milk predecessors to the first upper and the four lower incisors (?) of the dugong, and of the two anterior mandibular cheek teeth of the manatee; and discussed the bearings of these facts on the inter-relationships and affinities of the order Sirenia.

(11) Dr. H. C. McCook—Can Spiders Prognosticate Weather Changes? Dr. McCook first stated briefly the widespread popular opinion that spiders fairly indicate the weather by ceasing to spin before foul weather, and weaving freely before fine weather. He then gave a few extracts from his journal of observations on this point extending over six years, the tenor of which is that the popular opinion has no basis in fact. Many species of orb-weavers, which were colonized and kept under close observation, made snares freely before rains and storms, frequently even in the intervals between heavy rains.

(12) Mr. G. Swainson, some Notes on Marine and Freshwater *Chironomus*.

(13) Rev. Hilderic Friend, on British Earthworms. The author distinguishes between the four genera—*Lumbricus*, *Allolobophora*, *Allurus*, and *Dendrobæna*—to which British earthworms belong, and gives an account of the different species, some of which are new to science.

(14) Mr. H. Newman Laurence, the Human Body as a Conductor of Electricity.

(15) Prof. J. B. Haycraft, Fertilization of the Eggs of the Stickleback.

The two following papers, also on the programme, were taken as read:—

(16) Prof. Emile Yung, la Fonction Dermatoptique chez le Ver de Terre, and

(17) M. J. Richard, Note sur l'Œil Latéral des Copepodes du genre Pleuromma. The lateral eye in *Pleuromma* is variable in position, but is more often on the right side than on the left, and seems more constant in males than in females.

The following demonstrations were also given during the afternoon:—The Formation of Pearls (by Mr. Albert F. Calvert), Interesting British Food Fishes (by Mr. E. W. L. Holt), and the Structure of *Myeloxylon* (by Mr. A. C. Seward).

GEOGRAPHY AT THE BRITISH ASSOCIATION.

THE work of the Geographical Section was overtaken in four meetings, the large attendance at which was evidence that the papers read met at least with popular approval. It is more satisfactory to gather from the opinions expressed by specialists that many of the papers were solid and original, and that from the scientific standpoint the average work was of high excellence. Without doubt the most important of the new results announced to the Section was Dr. Schlichter's admirable development of a photographic process for determining longitude by the almost disused method of lunar distances. The practical value of the invention is very great, especially with regard to the mapping of partially known continents.

Like all other departments of the Association, Section E owed much of its success to the distinguished foreigners who took part in its proceedings. The papers by the Prince of Monaco and the occasional remarks of Baron von Richthofen were much appreciated. Two ladies read papers, Mrs. Bishop recounting her adventures on the borders of Tibet with her well-known literary grace, and Mrs. Grove giving a short, bright account of the rainless regions of Chile.

Prof. James Geikie's presidential address, although based entirely on geological reasoning, was truly geographical in so far as it utilized geology only for the purpose of explaining the origin of the existing surface conditions of the globe. As presenting the only sound basis of physical geography, this opening address proved to be one of the best and most original with which Section E has ever been favoured. Unfortunately, Prof. Geikie was prevented by illness from presiding at all the meetings, but his place was taken by the vice-presidents, Colonel Godwin Austen, Mr. H. J. Mackinder, Mr. E. G. Ravenstein, and Mr. Coutts Trotter.

The First Ascent of Oraefa Jökull.—In the absence of the author, Mr. J. Coles read an account by Mr. F. W. W. Howell of the first ascent of Oraefa Jokull in Iceland. Mr. Howell succeeded in making the ascent on August 12 last year, after several previous failures. Although only 6550 feet in height the mountain presented remarkable difficulties on account of the irregularity of the ice.

Place Names.—Dr. J. Burgess, in the course of a paper on place names, urged a uniform system of transliteration from Oriental alphabets as more scholarly and more satisfactory than any attempt to represent the sound of names phonetically. In no other way could uniformity of spelling be arrived at, and the diverse spellings now in use made the study of Asiatic geography in particular very toilsome and irritating. With regard to Gaelic names there were several serious errors in spelling on the ordnance map, but at the suggestion of Sir Charles Wilson a Committee of the Royal Scottish Geographical Society had taken the matter up, and aided by local committees were introducing important corrections. A lively discussion followed the reading of this paper, in which Sir Charles Wilson, Mr. Mackinder, Prof. Thomas Smith, and others took part. A Committee of the Association was formed to co-operate with the Scottish Society, and received a small grant to aid in the thorough revision of the orthography of Gaelic place names.

Effects of Rainfall in Formosa.—Mr. John Thomson, of London, gave an account of the effect of rainfall on the scenery of Formosa, illustrated by a number of fine photographs. The situation of the island and its mountainous structure conspire to give prominence to the effect of rain-action; the wind blowing in from the warm current of the *Kuro Siwo* strikes against a mountainous ridge which runs the whole length of the island and culminates in a summit 12,000 feet high. The mountain side to windward is scored with deep ravines, and the streams choked with huge boulders in course of transport to the coast-plains, which are deeply covered by fine alluvium washed down from the heights.

The Windings of Rivers.—Mr. J. Y. Buchanan, in a short paper, discussed the windings of rivers from the standpoint of hydrodynamics.

Lesser Tibet.—Mrs. Bishop (Miss Isabella Bird) described a journey undertaken in 1889, on the borderland of Tibet, which she approached from Leh, in Kashmir. The intensity of radiation at great altitudes, giving very hot days and cold nights, was observed to lead to a very rapid disintegration of the rocks, resulting in the formation of immense fields of gravel. Although presenting a vivid picture of the topography and scenery of the trans-Himalayan borderland, Mrs. Bishop entered more fully into the characteristics of the people, contrasting the false, suspicious, and cringing natives of Kashmir with the truthful, trustful, and independent people of Tibet, who always welcomed her warmly and dealt with her fairly.

The North Atlantic.—The Prince of Monaco read two papers on his oceanographical work, the first bearing on his experiments with floats on the surface circulation of the Gulf Stream, and its associated system of currents. About 10 per cent. of the floats thrown over from the Prince's yacht have been recovered, and by taking into account the position in which they were found and the date, important confirmation of the theoretical system of circulation was obtained. The current was found to be a circular whirl, with its centre a short distance south-west of the Azores. Floats thrown over near the centre were not recovered for many years, but those launched to the north or the south were thrown ashore more speedily on the coast of France, Spain, Portugal, North Africa, or in the West Indies. The only escape from the whirl was the Gulf-Stream drift towards Norway and the Arctic Sea. The mean rate of circulation was calculated as about 4½ miles per day, and the rate of movement was found to be more rapid in the western than in the eastern half of the whirl. The Prince's second paper set forth the advantages which would accrue to meteorology and to navigation if the atmospheric conditions of the North Atlantic could be observed and telegraphed daily to Europe. He pointed out that the Bermudas, the Azores, Madeira, the Canaries, and the Cape Verd Islands were, or would very soon be, in telegraphic communication with Europe. If high and low level observatories were established in these islands it would be possible to construct very fair synoptic charts of the North Atlantic, and vastly improve upon the useful Pilot Charts now compiled by the Washington Weather Bureau. The Prince was willing that all observations should be collected at Monaco, where the Government of the Principality would discuss and publish the data, and he suggested that the Governments most interested should send delegates to a conference to be held next winter at Monaco in order to discuss the feasibility of the scheme. Dr. A. Buchan, in commending the Prince's suggestions, said that the surface temperature of the North Atlantic had been proved to have an influence on the direction of cyclones crossing it, and consequently on the weather of the British Islands and western Europe. He thought a properly equipped low-level station on the Bermudas was the first desideratum; then a similar station on the Azores, to be followed by a high-level observatory. The results at Ben Nevis warranted the expectation of great advances, not only in knowing the weather of the Atlantic, but in forecasting weather for Western Europe, if the Prince's scheme received the encouragement which it deserved.

Detailed Oceanography and Meteorology.—Mr. J. Y. Buchanan described his observations on the temperature and density of the water in the Gulf of Guinea in connection with the counter-equatorial current. Dr. H. R. Mill gave a brief account of the physical geography of the Firth of Forth, dwelling particularly on the relation between tidal and solar variations of temperature in the water. The puzzling fact that in the Firth of Forth the water at high tide is saltest when that phase occurs in the afternoon was explained by the high water of spring tides occurring at that hour. Mr. H. N. Dickson, in a short paper, urged the claims of meteorology as a subject of instruction with special regard to its place in physical geography.

The Desert of Atacama.—Mrs. Lilly Grove, of Oxford, gave a vivid description of a journey through the Atacama desert, including a trip by rail from Antofagasta to Uyuni at an elevation of 13,000 feet in the Andes.

Photography and Surveying.—Colonel Tanner explained the system of photographic surveying which he has developed on the Himalayan survey. By the use of a finely ruled grating the angular intervals between prominent objects could be estimated, and in cases where detailed triangulation was impracticable very fair maps could be compiled from photographs taken from several prominent centres.

Determination of Longitude by Photography.—Dr. H. Schlichter communicated a most important paper, summing up a long series of experiments, and an investigation of the mathematical formulæ required in calculating longitude from lunar distances. His method enables him in favourable circumstances to fix the longitude to within 6″, an approximation hitherto only possible by telegraphic time comparisons. His summary is as follows:—

"Lunar distances as a means for the strictly accurate determination of geographical longitudes have been little used of late, partly on account of the splendid chronometers with which ships are now provided, and partly owing to the inaccuracies of the instruments commonly employed for lunars. For exploring expeditions on land, however, chronometers are of little value, and the other astronomical phenomena which may be used besides lunar distances are either too difficult for accurate observation by the majority of travellers, or occur too seldom, or are not accurate enough. The author therefore introduces a new method of observation and measurement of lunar distances, viz. by obtaining a parallel series of photographs of the moon and a fixed star or planet on one plate, and afterwards measuring the distances on the plate. For the elimination of all possible inaccuracies of the photographic film or of the lens, the lunar distances thus registered are checked by repeatedly photographing on the same plate two fixed stars, the positions of which are given in the *Nautical Almanac*, and the angular distances of which can easily be computed therefrom. The angular distances of the photographic lunars are then found by a simple proportion. The time for taking a set of eight photographic lunars on one plate does not exceed three or four minutes, and micrometric measurements show with perfect accuracy the change of the lunar distances (owing to the movement of the moon) during each interval of the eight observations. The minute accuracy of the method is hereby established. The micrometric measurements on the plate are made by means of the same *réseau* which is employed by the principal observatories for stellar photography, and the measurements may therefore be regarded as absolutely correct. Results thus obtained give the correct longitude of the place of observation. The author proposes to use this method for scientific expeditions into the interior of continents, &c., as well as for the further determination and correction of secondary meridians in navigation. For both purposes it is especially adapted on account of its minute accuracy and great simplicity."

African Travels.—The whole of one day was devoted to the reading of papers bearing on Africa, almost all having reference to South Africa. Mr. E. Wilkinson described two journeys which he had made in the Kalahari Desert. Mr. Theodore Bent summarized in an interesting manner the results of his explorations at Zimbabwe; a paper on the orientation of which was also read by Mr. Swan. In the report of the committee appointed to assist in the exploration of Zimbabwe, it was announced that Mr. and Mrs. Bent intended to pursue their investigations into African ruins of the Zimbabwe type in Abyssinia. Mr. John Buchanan gave an account of the industrial resources of Nyasaland, which his long experience there enabled him to do with authority. The fertility of the soil, and the intelligence and willingness to work of the people, were advantages common to few parts of tropical Africa. A staple commodity was still wanting, but there were unmistakable signs that this would before long be found in coffee, which has been grown with great and increasing success. Firm government of the country, the absolute suppression of the slave-trade, and of intertribal wars, were almost certain to result from the recent extension of the British protectorate; but the problem of communication remained as a bar to the effective development of the country. With really free traffic on the Zambesi and lower Shire, and a railway, or at least a steam tramway, on the new road from Chilomo to Lake Nyasa, the success of Nyasaland commercially would be assured. Lieutenant Crichton-Browne gave a popular account of a recent journey to Lobengula's capital, and of an interview with that monarch. At the close of this paper Mr. Joseph Thomson, whose health is still in a very unsatisfactory state, made a few remarks, the first he has been able to make in public since his return invalided from Africa a year ago. Dr. A. H. Hallen described the Haussa country, in the language of which he is specially interested. He hopes to be able, under the auspices of the recently-founded Haussa Association, to proceed to the western Sudan, and continue his studies in the country itself. Mr. Ravenstein submitted the report of the Committee on African meteorology, of which Mr. Symons, F.R.S., was secretary. The Committee has collected a considerable number of unpublished records of meteorological observations in tropical Africa, and has charged itself with exercising a friendly influence over existing stations and the equipment of new stations likely to promote a better knowledge of the climatological conditions of the continent. Instructions of an eminently practical kind have been drawn up, and by the circulation of these and the grant of sets of instruments to suitable observers, it is hoped that the special difficulties of tropical observing may be overcome. The committee has been reappointed, with the addition of Dr. H. R. Mill as secretary.

Proposed New Map of the Globe.—Mr. E. G. Ravenstein explained Prof. Penck's scheme of a new map of the world, on the scale of 1 to 1,000,000, or about sixteen miles to an inch. It was proposed to draw each sheet on an independent projection, the sheets embracing 5° in each direction, except those for latitudes higher than 60°, which would have a width of 10° of longitude. The map would be contoured at 100, 300, 500, and 1200 metres, hills would be printed in brown, and rivers in blue. The official spelling of all names written in the Roman alphabet would be adhered to, accepted names in other alphabets would be transliterated on a system to be afterwards agreed on, and names in unwritten languages would be rendered phonetically. The land surface of the globe would be represented in 769 sheets, and on an edition of 1000 copies it is estimated that there would be a deficit of over £100,000 if the sheets were sold at 2*s.* This sum would require to be subscribed by the Governments interested, or by private individuals. The practicability of such a map is proved by the fact that Mr. Ravenstein has himself produced with the aid of the Royal Geographical Society 46 five-degree sheets of a map of Africa. The utility of the new map is universally conceded.

Recent Travels.—Mr. Walker Harris described an adventurous journey through Yemen in the early part of this year, during a rebellion of the Arabs against the Turks. In spite of many difficulties, including imprisonment by the Turkish authorities, Mr. Harris succeeded in reaching Sanaa from Aden, and found the country to be well watered, of magnificent fertility, and by no means badly cultivated.

Mr. Coutts Trotter summarized the recent advances in the exploration and organization of British New Guinea.

Mr. H. O. Forbes described a visit to the Chatham Islands, where he discovered the bones of a remarkable flightless bird, identical with an extinct species also found in New Zealand, which is separated by 450 miles of deep water. The inevitable inference is that a land connection must formerly have existed between the two groups of islands. The importance of a careful search for similar remains in other islands of the southern hemisphere in the light of geographical distribution and speculations as to former lands is obvious.

Mr. W. R. D. Beckett, of the British Consular service in Siam, was the first Englishman to descend the Mekong river from the Eastern Laos States to Saigon, and described the various incidents of his adventurous journey.

Mr. C. W. Campbell, of the British Consular service in China, described his journey through Northern Korea, reporting favourably on the people as compared with the Chinese in their treatment of strangers.

Other Papers.—Prof. P. H. Schoute brought forward a new scheme for draining the Zuyder Zee, and Mr. Yule Oldham, lecturer on geography at Owens College, recalled attention to the early discoveries of Cadamosto on the west of Africa in the fifteenth century.

Sub-section on Chemical Oceanography.—A joint meeting of Sections B and E was held under the presidency of Mr. Buchanan for the consideration of a series of papers on oceanography. Mr. Buchanan communicated the result of some observations of the density of the water at a depth of 2000 fathoms off the coast of South America made by Captain Thomson, of the telegraph ship *Silvertown*. They are held to demonstrate that the deep water there has come direct from the Antarctic Sea. Prof. Pettersson gave a detailed and elaborate paper on the hydrography of the Kattegat and Baltic, illustrated by numerous special maps. Observations were made simultaneously at a number of points in the Baltic and its approaches; samples of water were preserved in sealed tubes for estimation of gases, and the density was in all cases measured on shore by means of Sprengel's pyknometer. The excess of precipitation over evaporation was found to cause an outflow of comparatively fresh water and a progressive decrease in the salinity from the Skagerrak inward. The fresh Baltic stream flows close round the coast of Norway as it escapes into the Atlantic. An undercurrent of salt water inward takes place, partly by reaction and partly by the rising up of the deeper layers against the ridges which divide the Baltic area into basins. This action is not uniform, but occurs by successive impulses and pauses. The physical boundary between the North Sea and the Baltic is not in the Belts, but along the ridge joining Rügen and Felster. The great mass of Baltic water from Rügen to the Gulf of Finland is of uniform salinity; it grows salter toward the North Sea, and freshens rapidly in the Gulf of Bothnia. In this region of uniform salinity temperature appears to be the chief cause of circulatory movement. By winter cooling a layer of intermediate minimum temperature is usually formed, in which flakes of ice may be produced that rise to the surface and consolidate there. Indications derived from observations fourteen years apart point to a partial or complete stagnation of the water in the deeper parts of the Baltic basin. The fresh Baltic stream is felt in summer far to the north along the Atlantic coast of Norway, but in winter it is greatly reduced, and comparatively warm North Sea water (4° to 6° C.) comes into the Skagerrak. This influx is coincident with the commencement of the great herring fishery, which comes to an end when the cold Baltic outflow is re-established in spring.

Dr. Andrussoff, of St. Petersburg, summarized the results of the recent Russian investigations on the Black Sea, the most remarkable discovery being the fact that below the depth of 200 fathoms the great mass of the water is stagnant, and so highly charged with sulphuretted hydrogen that all life is impossible.

Each paper was followed by animated discussion, in which Dr. John Murray, Dr. Buchan, Prof. Hartley, Dr. J. Gibson, Mr. Irvine, and Dr. H. R. Mill took part.

THE AMERICAN ASSOCIATION, PRESIDENT'S ADDRESS.[1]

A DIVISION of science has a work of its own to do, a work that well might be done for its own sake, and still more must be done in payment of what is due to the other divisions. Each section of our Association has its just task, and fidelity to this is an obligation to all the sections. Those engaged in any labour of science owe a debt to the world at large, and can be called to give an account of what they are doing, and what they have to do, that the truth may be shown on all sides.

If it be in my power to make the annual address of this meeting of any service at all to you who hear it—in your loyalty to the Association—I would bring before you some account of the work that is wanted in the science of chemistry. Of what the chemists have done in the past the arts of industry speak more plainly than the words of any address. Of what chemists may do in the future it would be quite in vain that I should venture to predict. But of the nature of the work that is waiting in the chemical world at the present time I desire to say what I can, and I desire to speak in the interests of science in general. The interests of science, I am well assured, cannot be held indifferent to the interests of the public at large.

It is not a small task to find out how the matter of the universe is made. The task is hard, not because of the great quantity in which matter exists, nor by reason of the multiplicity of the kinds and compounds of matter, but rather from the obscurity under which the actual composition of matter is hidden from man. The physicists reach a conclusion that matter is an array of molecules, little things, not so large as a millionth of a millimetre in size, and the formation of these they leave to the work of the chemists. The smallest objects dealt with in science, their most distinct activities become known only by the widest exercise of inductive reason.

The realm of chemical action, the world within the molecules of matter, the abode of the chemical atoms, is indeed a new world and but little known. The speculative atoms of the ancients, mere mechanical divisions, prefiguring the molecules of modern science, yet gave no sign of the chemical atoms of this century, nor any account of what happens in a chemical change. A new field of knowledge was opened in 1774 by the discovery of oxygen, and entered upon in 1804 by the publications of Dalton, a region more remote and more difficult of access than was the unknown continent toward which Christopher Columbus set his sails three centuries earlier. The world within molecules has been open for only a hundred years. The sixteenth century was not long enough for an exploration of the continent of America, and the nineteenth has not been long enough for the undertaking of the chemists. When four centuries of search shall have been made in the world of chemical formation, then science should be ready to meet a congress of nations, to rejoice with the chemist upon the issue of his task.

It is well known that chemical labour has not been barren of returns. The products of chemical action, numbering thousands of thousands, have been sifted and measured and weighed. If you ask what happens in a common chemical change you can obtain direct answers. When coal burns in the air, how much oxygen is used up, can be stated with a degree of exactness true to the first decimal of mass, perhaps to the second, yet questionable in the third. How much carbonic acid is made can be told in weight and in volume with approaching exactness. How much heat this chemical action is worth, how much light, how much electro-motive force, what train-load of cars it can carry, how long it can make certain wheels go round,—for these questions chemists and physicists are ready. With how many metals carbonic acid will unite, how many ethers it can make into carbonates, into what classes of molecules a certain larger fragment of carbonic acid can be formed, the incomplete records of these things already run through a great many volumes. These carboxylic bodies are open to productive studies, stimulated by various sorts of inquiry and demands of life. Such have been the gatherings of research. They have been slowly drawn into order, more slowly interpreted in meaning. The advance has been constant, deliberate, sometimes in doubt, always persisting and gradually gaining firmer ground. So chemistry has reached *the period of definition*. Its guiding theory has come to be realized.

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[1] Address by Prof. A. B. Prescott, the retiring President, delivered at the Rochester meeting of the American Association for the Advancement of Science, August, 1892.

"The atomic theory" has more and more plainly appeared to be the central and vital truth of chemical science. As a working hypothesis it has directed abstruse research through difficult ways to open accomplishment in vivid reality. As a system of knowledge, it has more than kept pace with the rate of invention. As a philosophy, it is in touch with profound truth in physics, in the mineral kingdom, and in the functions of living bodies. As a language it has been a necessity of man in dealing with chemical events. Something might have been done, no doubt, without it, had it been possible to keep it out of the chemical mind. But with a knowledge of the primary elements of matter, as held at the beginning of this century, some theory of chemical atoms was inevitable. And whatever theory might have been adapted, its use in investigation would have drawn it with a certainty into the essential features of the theory now established. It states the constitution of matter in terms that stand for things as they are made. The mathematician may choose the ratio of numerical notation, whether the ratio of ten or some other. But the chemist must find existing ratios of atomic and molecular mass, with such degree of exactness as he can attain. Chemical notation, the index of the atomic system, is imperfect, as science is incomplete. However defective, it is the resultant of a multitude of facts. The atomic theory has come to be more than facile language, more than lucid classification, more than working hypothesis, it is *the definition of the known truth in the existence of matter*.

The chemical atom is known, however, for what it does, rather than for what it is. It is known as a centre of action, a factor of influence, an agent of power. It is identified by its responses, and measured by its energies. Concealed as it is, each atom has given proof of its own part in the structure of a molecule. Proofs of position, not in space but in action, as related to other atoms, have been obtained by a multitude of workers with the greatest advantage. The arrangement of the atoms in space, however, is another and later question, not involved in the general studies of structure. But even this question has arisen upon its own chemical evidences, for certain bodies, so that the "configuration" of the molecule has become an object of active research.

Known for what it does, the atom is not clearly known for what it is. Chemists, at any rate, are concerned mainly with what can be made out of atoms, not with what atoms can be made of. Whatever they are, and by whatever force or motion it is that they unite with each other, we define them by their effects. Through their effects they are classified in the rank and file of the periodic system. The physicists, however, do not stop short of the philosophical study of the atom itself. As a vibratory body its movements have been under mathematical calculations; as a vortex ring its pulsations have been assumed to agree with its combining power. As an operating magnet its interaction with other like magnets has been predicated as the method of valence. There are, as I am directly assured, physicists of penetration and prudence now looking with confidence to studies of the magnetic relations of atoms to each other.[1] Moreover, another company of workers, the chemists of geometric isomerism, assume a configuration of the atoms, in accord with that of the molecule.

The stimulating truth of the atomic constitution of the molecule, a great truth in elastic touch with all science, excites numerous hypotheses, which, however profitable they may be, are to be stoutly held at a distance from the truth itself. Such are the hypotheses of molecular aggregation into crystals and other mineral forms. Such are the biological theories of molecules polymerizing into cells, and of vitality as a chemical property of the molecule. Such are the questions of the nature of atoms, and the genesis of the elements as they are now known, questions on the border of metaphysics. Let all these be held distinct from the primary law of the atomic constitution of simple molecules in gaseous bodies, an essential principle in an exact science. The chemist should have the comfortable assurance, every day, as he plies his balance of precision, that the atom-made molecules are there, in their several ratios of quantity, however many unsettled questions may lie around about them. Knowledge of molecular structure makes chemistry a science, nourishing to the reason, giving dominion over matter, for beneficence to life.

Every chemical pursuit receives strength from every advance in the knowledge of the molecule. And to this knowledge, none the less, every chemical pursuit contributes. The analysis of a mineral, whether done for economic ends or not, may furnish a distinct contribution toward atomic valence. The further examination of steel in the cables of a suspension bridge is liable to lead to unexpected evidence upon polymeric unions. Rothamsted farm, where ten years is not a long time for the holding of an experiment, yields to us a classic history of the behaviour of nitrogen, a history from which we correct our theories. The analysis of butter for its substitutes has done something to set us right upon the structure of the glycerides. Clinical inspection of the functions of the living body fain finds a record of molecular transformations too difficult for the laboratory. The efforts of pharmaceutical manufacture stimulate new orders of chemical combination. The revision of the pharmacopœa every ten years points out a humiliating number of scattered errors in the published constants on which science depends. The duty of the engineer, in his scrutiny of the quality of lubricating oils, brings a more critical inquiry into the laws of molecular movement. There is not time to mention the many professions and pursuits of *men who contribute toward the principles of chemistry* and hold a share therein. If it be the part of pure science to find the law of action in nature, it is the part of applied science both to contribute facts and to put theory to the larger proof. In the words of one who has placed industry in the greatest of its debts to philosophic research, W. H. Perkin, "There is no chasm between pure and applied science, they do not even stand side by side, but are linked together." So in all branches of chemistry, whether it be termed applied or not, the best workers are most strongly bound as one, in their dependence upon what is the known of the structure of the molecule.

Studies of structure were never before so inviting. In this direction and in that especial opportunities appear. Moreover the actual worker here and there breaks into unexpected paths of promise. Certainly the sugar group is presenting to the chemist an open way from simple alcohols on through to the cell substances of the vegetable world. And nothing anywhere could be more suggestive than the extremely simple unions of nitrogen lately discovered. They are likely to elucidate linkings of this element in great classes of carbon compounds, all significant in general chemistry. Then certain comparative studies have new attractions. As halogens have been upon trial side by side with each other, so for instance silicon must be put through its paces with carbon, and phosphorus with nitrogen. Presently, also, the limits of molecular mass, in polymers and in unions with water, are to be nearer approached from the chemical side, as well as from the side of physics, in that attractive but perplexing border ground between affinity and the states of aggregation.

Such is the extent and such the diversity of chemical labour at present that every man must put limits to the range of his study. The members of a society or section of chemistry, coming together to hear each other's researches, are better able, for the most part, to listen for instruction than for criticism. Still less prepared for hasty judgment are those who do not come together in societies at all. Even men of eminent learning must omit large parts of the subject, if it be permitted to speak of chemistry as a single subject. These considerations admonish us to be liberal. When metallurgical chemistry cultivates scepticism as to the work upon atomic closed chains, it is a culture not the most liberal. When a devotee of organic synthesis puts a low value upon analytic work, he takes a very narrow view of chemical studies. When the chemist who is in educational service disparages investigations done in industrial service, he exercises a pitiful brevity of wisdom.

The pride of pure science is justified in this, that its truth is for the nurture of man. And the ambition of industrial art is honoured in this, its skill gives strength to man. It is the obligation of science to bring the resources of the earth, its vegetation and its animal life, into the full service of man, making the knowledge of creation a rich portion of his inheritance, in mind and estate, in reason and in conduct, for life present and life to come. To know creation is to be taught of God.

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[1] "The results of molecular physics point unmistakably to the atom as a magnet, in its chemical activities."—A. E. Dolbear, in a personal communication.

I have spoken of the century of beginning chemical labour, and have referred to the divisions and specialities of chemical study. What can I say of the means of uniting the earlier and later years of the past, as well as the separated pursuits of the present, in one mobile working force? Societies of science are among these means, and it becomes us to magnify their office. For them, however, all that we can do is worth more than all we can say. And there are other means, even more effective than associations. Most necessary of all the means of unification in science is the use of its literature.

It is by published communication that the worker is enabled to begin, not where the first investigation began, but where the last one left off. The enthusiast who lacks the patience to consult books, presuming to start anew all by himself in science, has need to get on faster than Antoine L. Lavoisier did when he began, an associate of the French Academy in 1768. He of immortal memory, after fifteen eventful years of momentous labour, reached only such a combustion of hydrogen as makes a very simple class experiment at present. But however early in chemical discovery, Lavoisier availed himself of contemporaries. They found oxygen, he learned oxidation: one great man was not enough, in 1774, both to reveal this element and show what part it takes in the formation of matter. The honour of Lavoisier is by no means the less that he used the results of others, it might have been the more had he given their results a more explicit mention. Men of the largest original power make the most of the results of other men. Discoverers do not neglect previous achievement, however it may appear in biography. The masters of science are under the limitations of their age. Had Joseph Priestley lived in the seventeenth century he had not discovered oxygen. Had August Kekulé worked in the period of Berzelius, some other man would have set forth the closed chain of carbon combination, and Kekulé, we may be sure, would have done something else to clarify chemistry. Such being the limitations of the masters, what contributions can be expected in this age from a worker who is without the literature of his subject?

In many a town some solitary thinker is toiling intensely over some self-imposed problem, devoting to it such sincerity and strength as should be of real service, while still he obtains no recognition. Working without books, unaware of memoirs on the theme he loves, he tries the task of many with the strength of one. Such as he sometimes send communications to this Association. An earnest worker, his utter isolation is quite enough to convert him into a crank. To every solitary investigator I should desire to say, get to a library of your subject, learn how to use its literature, and possess yourself of what there is on the theme of your choice, or else determine to give it up altogether. You may get on very well without college laboratories, you can survive it if unable to reach the meetings of men of learning, you can do without the counsel of an authority, but you can hardly be a contributor in science except you gain the use of its literature.

First in importance to the investigator are the original memoirs of previous investigators. The chemical determinations of the century have been imported by their authors in the periodicals. The serials of the years, the continuous living repositories of all chemistry, at once the oldest and the latest of its publications, these must be accessible to the worker who would add to this science. A library for research is voluminous, and portions of it are said to be scarce, nevertheless it ought to be largely supplied. The laboratory itself is not more important than the library of science. In the public libraries of our cities, in all colleges now being established, the original literature of science ought to be planted. It is a wholesome literature, at once a stimulant and a corrective of that impulse to discovery that is frequent among the people of this country. That a good deal of it is in foreign languages is hardly a disadvantage; there ought to be some exercise for the modern tongues that even the public high schools are teaching. That the sets of standard journals are getting out of print is a somewhat infirm objection. They have no right to be out of print in these days when they give us twenty pages of blanket newspaper at breakfast, and offer us Scott's novels in full for less than the cost of a day's entertainment. As for the limited editions of the old sets, until reproduced by new types, they may be multiplied through photographic methods. When there is a due demand for the original literature of chemistry, a demand in accord with the prospective need for its use, the supply will come, let us believe, more nearly within the means of those who require it than it now does.

What I have said of the literature of one science can be said, in the main, of the literature of the other sciences. And other things ought to be said, of what is wanted to make the literature of science more accessible to consulting readers. *A great deal of indexing is wanted.* Systematic bibliography, both of previous and of current literature, would add a third to the productive power of a large number of workers. It would promote common acquaintance with the original communications of research, and a general demand for the serial sets. Topical bibliographies are of great service. In this regard I desire to ask attention to the annual reports of the committee on Indexing Chemical Literature, in this association for nine years past, as well as to recent systematic undertakings in geology, and like movements in zoology and other sciences. Also to the Index Medicus, as a continuous bibliography of current professional literature.

Societies and institutions of science may well act as patrons to the bibliography of research, the importance of which has been recognized by the fathers of this Association. In 1855, Joseph Henry, then a past president of this body, memorialized the British Association for cooperation in bibliography, offering that aid of the Smithsonian Institution which has so often been afforded to publications of special service. The British Association appointed a committee, who reported in 1857, after which the undertaking was proposed to the Royal Society. The Royal Society made an appeal to her Majesty's Government, and obtained the necessary stipend. Such was the inception of the Royal Society Catalogue of scientific papers of this century, in eight quarto volumes, as issued in 1867 and 1877. Seriously curtailed from the generous plan of the committee who proposed it, limited to the single feature of an index of authors, it is nevertheless of great help in literary search. Before any list of papers, however, we must place a list of the serials that contain them, as registered by an active member of this Association, an instance of industry and critical judgment. I refer to the well-known catalogue of scientific and technical periodicals, of about five thousand numbers, in publication from 1665 to 1882, together with the catalogue of chemical periodicals by the same author.[1]

Allied to the much needed service in bibliography, is the service in compilation of the Constants of Nature. In the preface of his dictionary of solubilities, in 1856, Prof. Storer said "that chemical science itself might gain many advantages if all known facts regarding solubility were gathered from their widely-scattered original sources into one special comprehensive work." That the time of the philosophical study of solution was near at hand has been verified by recent extended monographs on this subject. In like manner Thomas Carnelley in England, and early and repeatedly our own Prof. Clarke in the United States,[2] bringing multitudes of scattered results into co-ordination, have augmented the powers of chemical service.

What bibliography does for research, the Handwörterbuch does for education, and for technology. It makes science wieldy to the student, the teacher, and the artisan. The chief dictionaries of science, those of encyclopædic scope, ought to be provided generally in public libraries, as well as in the libraries of all high schools.[3] The science classes in preparatory schools should make an acquaintance with scientific literature in this form. If scholars be assigned exercises which compel reference reading, they will gain a beginning of that accomplishment too often neglected, even in college, how to use books.

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[1] "Bolton's Catalogue of Scientific and Technical Periodicals" (1885: Smithsonian) omits the serials of the Societies, as these are the subject of Scudder's "Catalogue of Scientific Serials" (1879: Harvard Univ.). On the contrary, Bolton's "Catalogue of Chemical Periodicals" (1885: N. Y. Acad. Sci.) includes the publications of Societies as well as other serials, Chemical technology is also represented in the last-named work.

[2] The service of compilation of this character is again indicated by this extract from Clarke's introduction to the first edition of his "Constants" (1873): "While engaged upon the study of some interesting points in theoretical chemistry, the compiler of the following tables had occasion to make frequent reference to the then existing lists of specific gravities. None of these, however, were complete enough. . . ."

[3] The statistics of school libraries in the United States are very meagre, the expenditures for them being included with that for apparatus. For libraries and apparatus of all common schools, both primary and secondary, the annual expenditure is set at 987,048 dollars, which is about seven-tenths of one per cent. of the total expenditure for these schools.

The library is a necessity of the laboratory. Indeed, there is much in common between what is called the laboratory method, and what might be called the library method, in college training. The educational laboratory was instituted by chemistry, first taking form under Liebig at Giessen only about fifty years ago. Experimental study has been adopted in one subject after another, until, now, the "laboratory method" is advocated in language and literature, in philosophy and law. It is to be hoped that chemistry will not fall behind in the later applications of "the new education" in which she took so early a part.

The advancement of chemical science is not confined to discovery, nor to education, nor to economic use. All of those interests it should embrace. To disparage one of them is injurious to the others. Indeed, they ought to have equal support. It would be idle to inquire into their respective advantages. This much, however, is evident enough, chemical work is extensive, and there is immediate want of it.

Various other branches of science are held back by the delay of chemistry. Many of the material resources of the world wait upon its progress. In the century just before us the demands upon the chemist are to be much greater than they have been. All the interests of life are calling for better chemical information. Men are wanting the truth. The biologist on the one hand, and the geologist on the other, are shaming us with interrogatories that ought to be answered. Philosophy lingers for the results of molecular inquiry. Moreover the people are asking direct questions about the food they are to eat, or not to eat, asking more in a day than the analyst is able to answer in a month. The nutritive sources of bodily power are not safe, in the midst of the reckless activity of commerce, unless a chemical safeguard be kept, a guard who must the better prepare himself for his duty.

Now if the people at large can but gain a more true estimation of the bearing of chemical knowledge, and of the extent of the chemical undertaking, they will more liberally supply the sinews of thorough-going toil. It must be more widely understood that achievements of science, such as have already multiplied the hands of industry, do not come by chances of invention, nor by surprises of genius. It must be learned of these things that they come by breadth of study, by patience in experiment, and by the slow accumulations of numberless workers. And it must be made to appear that the downright labour of science actually depends upon means of daily subsistence. It must be brought home to men of affairs, that laboratories of seclusion with delicate apparatus, that libraries, such has bring all workers together in effect, that these really cost something in the same dollars by which the products of industrial science are measured. Statistics of chemical industry are often used to give point to the claims of science. For instance, it can be said that this country, not making enough chemical wood pulp, has paid over a million dollars a year for its importation. That Great Britain pays twelve million dollars a year for artificial fertilizers, from without. That coal tar is no longer counted a bye-product having risen in its value to a par with coal gas. But these instances, as striking as numerous others, still tend to divert attention from the more general service of chemistry as it should be known in all the economies of civilization.

It is not for me to say what supplies are wanted for the work of chemists. These wants are stated, in quite definite terms, by a sufficient number of those who can speak for themselves. But if my voice could reach those who hold the supplies, I would plead a most considerate hearing of all chemical requisitions, and that a strong and generous policy may in all cases prevail in their behalf.

If any event of the year is able to compel the attention of the world to the interests of research, it must be the notable close of that life of fifty years of enlarged chemical labour, announced from Berlin a few months ago. When thirty years of age, August Wilhelm von Hofmann, a native of Giessen and a pupil of Liebig, was called to work in London. Taking hold of the organic derivatives of ammonia, and presently adopting the new discoveries of Wurtz, he began those masterly contributions that appear to have been so many distinct steps toward a chemistry of nitrogen, such as industry and agriculture and medicine have thriven upon. In 1850 he opened a memoir in the philosophical transactions with these words, "the light now begins to dawn upon the chaos of collected facts." Since that time the coal tar industry has risen and matured, medicine has learned to measure the treatment of disease, and agriculture to estimate the fertility of the earth. It seems impossible that so late as March of the present year, he was still sending his papers to the journals. If we could say something of what he has done we could say nothing of what he has caused others to do. And yet, let it be heard in these United States, without such a generous policy of expenditure for science as gave to Dr. Hofmann his training in Giessen, or brought him to London in 1848, or built for him laboratories in Bonn and Berlin, without such *provision by the State*, the fruits of his service would have been lost to the world. Ay, and for want of a like broad and prudent provision for research with higher education, in this country, other men of great love for science and great power of investigation every year fail of their rightful career for the service of mankind.

For the prosecution of research, in the larger questions now before us, no training within the limitations of human life can be too broad or too deep. No provision of revenue, so far as of real use to science, can be too liberal. The truest investigation is the most prudent expenditure that can be made.

In respect to the support that is wanted for work in science, I have reason for speaking with confidence. If I go beyond the subject with which I began I do not go beyond the warrant of the Association. This body has lately defined what its members may say, by creating a committee to receive endowments for the support of research.

There are men and women who have been so far rewarded, that great means of progress are in their hands, to be vigorously held for the best advantage. Strength is required to use large means, as well as to accumulate them. It is inevitable to wealth, that it shall be put to some sort of use, for without investment it dies. By scattered investment wealth loses personal force. The American Association, in the conservative interests of learning, proposes certain effective investments in science. If it be not given to every plodding worker to be a promoter of discovery, such at all events is the privilege of wealth, under the authority of this association. If it be not the good fortune of every investigator to reach knowledge that is new, there are, every year, in every section of this body, workers of whom it is clear that they would reach some discovery of merit, if only the means of work could be granted them. Whosoever supplies the means fairly deserves and will receive a share in the results. It is quite with justice that the name of Elizabeth Thompson, the first of the patrons, has been associated with some twenty-one modest determinations of merit recognized by this association.

"To procure for the labours of scientific men increased facilities" is one of the constitutional objects of this body. It is time for effectiveness towards this object. The Association has established its character for sound judgment, for good working organization, and for representave public interest. It has earned its responsibility as *the American trustee of undertakings in science.*

"To give a stronger . . . impulse . . . to scientific research" is another declaration of what we ought to do. To this end larger endowments are necessary. And it will be strange if some clear-seeing man or woman does not put ten thousand dollars, or some multiple of it, into the charge of this body for some searching experimental inquiry now waiting for the material aid. The committee upon endowment is ready for consultation upon all required details.

"To give . . . more systematic direction to scientific research" is likewise stated as one of our objects. To this intent the organization of sections affords opportunities not surpassed. The discussions upon scientific papers give rise to a concord of competent opinions as to the direction of immediate work. And arrangements providing in advance for the discussion of vital questions, as formally moved at the last meeting, will in one way or another point out to suitable persons such lines of labour as will indeed give systematic direction to research.

In conclusion, I may mention another, the most happy of the duties of the American Association. It is to give the hand of hospitable fellowship to the several societies who year by year gather with us upon the same ground. Comrades in labour and in refreshment, their efforts reinforce us, their faces brighten our way. May they join us more and more in the companionship that sweetens the severity of art. A meeting of good workers is a remembrance of pleasure, giving its zest to the aims of the year.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

1851 EXHIBITION SCIENCE SCHOLARSHIPS.—Her Majesty's Commissioners for the Exhibition of 1851, assisted by a committee of gentlemen experienced in scientific education, have made the following appointments to the science scholarships for the year 1892. The scholars have been students of science for at least three years, and have been recommended for the scholarships by the authorities of their respective Universities or Colleges, as indicating high promise of capacity for advancing science, or its applications, by original research. The scholarships are of the value of £150 a year, and are tenable for two years (subject to a satisfactory report at the end of the first year) in any University at home or abroad, or in some other institution to be approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of this country.

ARTHUR ELLIS, Major-General,
Secretary.

18, Victoria-street, Westminster, August, 1892.

University of Edinburgh.—Mr. Andrew John Herbertson.
,, Glasgow.—Mr. James Blacklock Henderson.
,, Aberdeen.—Mr. John Macdonald.
Mason Science College, Birmingham.—Mr. Lionel Simeon Marks.
University College, Bristol.—Mr. George Lester Thomas.
Yorkshire College, Leeds.—Mr. Harold Hart Mann.
University College, Liverpool.—Mr. James Terence Conroy.
Owens College, Manchester.—Mr. Thornton Charles Lamb.
University College, Nottingham.—Mr. Edward Arnold Medley.
Firth College, Sheffield.—Mr. William Henry Oates.
University College of North Wales.—Mr. Edward Taylor Jones (*conditionally*).
Queen's College, Cork.—Mr. George Ryce.
,, ,, Galway.—Mr. William Gannon.
University of Toronto.—Mr. Frederick J. Smale.
,, Adelaide.—Mr. James Bernard Allen.
,, New Zealand.—Mr. David Hamilton Jackson.
,, Sydney (*postponed from* 1891).—Mr. Samuel Henry Barraclough.

ROYAL COLLEGE OF SCIENCE, LONDON (SESSION 1891–92).—List of Scholarships, Prizes, and Associateships, awarded July 1892:—

First Year's Scholarships... ...	Spencer, Bernard E. West, George S. Gray, Charles J. Verney, Harry.	
Second Year's Scholarships ...	Allan, William. Melton, George R.	
"Edward Forbes" Medal and Prize of Books for Biology	West, William Vanstone, John H.	2 Medals and Prize divided.
"Murchison" Medal and Prize of Books for Geology	Starling, Sydney E.	
"Tyndall" Prize of Books for Physics Course I	Spencer, Bernard E.	
"De la Beche" Medal for Mining ...	Cooke, Lewis H.	
"Bessemer" Medal and Prize of Books for Metallurgy	Jeans, Harold.	
"Frank Hatton" Prize of Books for Chemistry	Perry, George H.	

Prizes of Books given by the Department of Science and Art.

Mechanics	Longbottom, John G.
Astronomical Physics	Bruce, James.
Practical Chemistry	Perry, George H.
Mining	Cooke, Lewis H.
Principles of Agriculture ...	Jones, Thomas.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 16.—M. Duchartre in the chair.—Theory of a condenser introduced into the secondary circuit of a transformer, by M. Désiré Korda.—Vaporization in boilers, by M. de Swarte.—On some new combinations of piperidine, by M. Raoul Varet.—On an application of chemical analysis for fixing the age of prehistoric human remains, by M. Adolphe Carnot. This determination is based upon the progressive diminution of fluorine contained in the fossil bones of the various geological ages. If the quantity contained in the most ancient remains be designated by 1, we shall have 0·64 for Tertiary remains, 0·35 for "Quaternary," and 0·05 or 0·06 for the recent ones. This fact was utilized in fixing the age of a human tibia found in the sandy layers of Billancourt (Seine) in the neighbourhood of some remains of undoubted Quaternary origin. The ratio of the quantity of fluorine contained in the animal fragments to that in the human tibia was found to be 0·469 or 0·578 to 0·066. This establishes the more recent origin of the tibia.—On a new genus of permio-carboniferous stems, the *G. Retinodendron Rigolloti*, by M. B. Renault. The specimen upon which this new genus has been founded was discovered by M. Rigollot in the silicified layers of Autun. It represents a stem 12 mm. thick, 3 mm. of which belong to the wood and 9 mm. to the bark. The latter is composed of several eccentric zones of gum or resin canals, and of cells with sclerified walls in regular alternation. The canals are arranged in continuous circular lines; their cavities enclose a brown substance which is sometimes granular. The structure of the wood indicates that the new genus belongs to the gymnosperms; its density and the small thickness of the ligneous cellular rays distinguish it from the ordinary cycads, while their composite nature makes it impossible to class them with the conifers. Hence it belonged to a family of gymnosperms which is actually extinct. It may be concluded that at no other epoch have the plants secreting gums, resins, tannin, &c., been more abundant, and that the carbonization of these products is the origin of the yellow or brown substances found not only in the bituminous schists, forming bands or small lenticular patches, but also in pitcoal, impregnating more or less the preserved tissues, and in cannel-coal, enclosing a large number of recognizable vegetable fragments.—Pancreatic diabetes, by MM. Lancereaux and A. Thiroloix. Further experiments show that there exists a diabetes actually consequent upon the destruction of the pancreas; this diabetes is not, however, caused by the absence of the external glandular secretion, but simply by the absence of the liquid secreted internally by the gland and absorbed by the blood-vessels and the lymphatics.—On a new treatment of the glanders, by MM. Claudius Nourri and C. Michel. This is identical with that applied recently to human tuberculosis, with which it has much in common.

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THURSDAY, SEPTEMBER 1, 1892.

EPIDEMICS, PLAGUES, AND FEVERS.

Epidemics, Plagues and Fevers: their Causes and Prevention. By the Hon. Rollo Russell. (London: Edward Stanford, 1892.)

IN this handbook the author has aimed at collecting together the main facts concerning preventable diseases and presenting them in a convenient form for the use of those interested in the promotion of public health. The work is in the main a compilation of extracts from the most varied sources, and references are given which enable the original authorities to be consulted. It is difficult to speak too highly of the care and industry with which Mr. Russell has fulfilled this task, and of the completeness with which the work has been brought up to date.

In an introductory chapter on the nature of spreading diseases in plants and animals the analogy is traced between such processes as dry-rot and yeast fermentation, and the action of disease germs upon the animal organism; a short account is given also of various epizoötic diseases.

Passing to the main subject of the book, the author deals *seriatim* with the different human diseases of microparasitic origin. A long chapter is devoted to cholera. Accepting provisionally Koch's comma-bacillus as its cause, Mr. Russell exhibits in a mass of evidence the conditions of filth and water pollution which enable the disease to maintain itself in its native home, India, and to spread thence in epidemic visitations to other parts of the world. In many parts of India much has been done by sanitary measures, such as drainage and improved water supply, to reduce the incidence of cholera: in a later part of the book stress is justly laid on the responsibility which rests on England in the matter of the sanitation of India. The measures by which cholera may be arrested are set forth in full, the most important being personal cleanliness, a pure water supply, and the disinfection of dejecta and soiled linen. No adequate account is given of the measures of notification and supervision which in this country replace strict quarantine.

Another important section of the book is devoted to consumption, which it is a pleasure to find included amongst preventable diseases. Nothing is more lamentable than the carelessness with which a phthisical patient is allowed to spread infection broadcast by the sputum, and though public opinion is not yet ripe for the question of seclusion of cases of consumption, much might yet be done by educating patients to disinfect the sputum and use reasonable precautions against the infection of members of their families. The diffusion of tubercle by means of domestic animals and especially by milk is enforced by Mr. Russell, and attention is drawn to the general sanitary measures such as drainage and ventilation which have already reduced its mortality in this country.

In the chapter on diphtheria mention is made of the recent researches of Klein and others showing the connection of this disease with a certain disease in cows and in cats. The author has drawn also on Dr. Thorne Thorne's recent Milroy lectures, but he has hardly laid sufficient emphasis on the aggregation of children in schools as the main cause of the late increase of urban, as compared with rural diphtheria mortality, a point to which Dr. Thorne draws especial attention.

The section on influenza is based on the most recent observations, and even contains in a note some account of Pfeiffer's and Canon's influenza bacillus. Exception must be taken to the statement that this organism is present in immense numbers in the blood. In the sputum it is extremely abundant, but in the blood, as a rule, only in the scantiest numbers.

Scarlet fever and small-pox have each a comparatively short chapter devoted to them. That on scarlet fever contains mention of the so-called "Hendon disease" in cows, to which the extensive outbreak in the north-west of London in 1885 was traced, and a good practical epitome of the precautions to be observed in the sick room. In the section on small-pox vaccination statistics are given, but we find no reference to the elaborate Local Government Report by Dr. Barry on the late Sheffield epidemic, which contains a mine of information on the most serious outbreak of small-pox in England in recent years, and should certainly have been noticed. The spread of the disease by aërial diffusion from small-pox hospitals is clearly illustrated.

Typhoid fever receives long and thorough consideration. Mr. Russell accepts the "typhoid bacillus" of Eberth, Klebs, and Gaffky as the true virus of the disease—a conclusion which is far from settled in the minds of many, inasmuch as the true lesions of the disease have not been reproduced by it. But this does not affect the questions at issue. The ordinary method by which the disease spreads, viz., excremental pollution of drinking water, is abundantly illustrated by numerous examples, and the contamination of milk is likewise mentioned. The thorough disinfection of typhoid dejecta is clearly a matter of the first importance, and a sound practical method of accomplishing this is much to be desired; at present it must be admitted that no adequate means has been devised.

Amongst the numerous other diseases which Mr. Russell has treated of, we are glad to notice that pneumonia finds a place; it is undoubted that some forms at least of inflammation of the lungs are infectious and preventable in the same manner as other specific fevers. The claims of rheumatic fever, which has also been included, to a similar position, are to say the least doubtful.

In the concluding chapters of the book, Mr. Russell deals with more general problems, such as susceptibility, immunity, the distribution of microbes, the origins of epidemics, and so forth. Gathering his evidence from various sources, he deals with these matters in a very impartial way. Thus in discussing immunity, while accepting provisionally the doctrine of phagocytosis, he by no means regards it as the only means by which micro-organisms are eliminated from the body. The germicidal powers of the fluids of the body receive due consideration as at least an equally important defensive agency. The scheme of a National Health Service is discussed in an appendix.

Mr. Russell is to be congratulated on the service which he has done to Public Health by the collection of this mass of information on its more important topics. It is only natural that a work which is essentially a compilation, should be of a somewhat patchwork character; but it is to be regretted that in some of the sections the different paragraphs do not offer more coherent reading. It would further have been an advantage to the general public, whose education in these matters is so essential an element in the further progress of public health, if so many technical terms had not been used without explanation. Occasional looseness of expression is to be noticed. As when we read of "Bacterium termo, the microbe of impure water," or, "the Zeiss system magnifies three to four thousand times." But to those for whom the book is specially written, those interested or officially concerned in the promotion of health, it will prove a valuable work of reference.

THE PHYSIOLOGY OF THE INVERTEBRATA.

The Physiology of the Invertebrata. By A. B. Griffiths, Ph.D., F.R.S. (Edin.), F.C.S. (London: L. Reeve and Co., 1892.)

STUDENTS of biology, and especially of physiology, have long wanted a book treating of the physiological problems of the invertebrate animals. It is true that what is sometimes called human physiology is in great measure the physiology of the lower animals. Physiologists, however, generally select for experiment animals which are as much as possible like themselves; it is comparatively seldom that they invade the invertebrate branches of animal life. There are vast fields there for exploration which are almost untouched from the physiological standpoint, and one can hardly doubt that great treasures in the way of fact and reasoning could be unearthed, which would throw light on the functions not only of these lower creatures themselves, but on the life problems of the higher animals also. The present book by Dr. Griffiths will therefore be welcomed as a first attempt to fill this gap. He is well known as one of the few who have carried the method of physiology down to the invertebrates, and his researches have been marked by great industry and patience.

In treating of invertebrate physiology, it is obvious that there are two courses open to a descriptive writer: one is to take the various sub-kingdoms as the main headings, and to treat of the different functions of each before proceeding to the next; the other method is to head the chapters with the functions—circulation, respiration, and the like—and to describe each of these in the various branches of the invertebrata. No doubt there is much to be said for each course. The latter, which is the one adopted in the present volume, appears, however, to have these disadvantages, that it involves a good deal of repetition, and that each chapter is split up into a number of small paragraphs, and there is thus but little continuous narrative. This is increased by the habit the author has of making extensive quotations, so that there is little uniformity of style; half a page will be given in the flowing style of Huxley, and the next half in the less fluent English of other writers. It appears to us it would have been better if Dr. Griffiths had given the results of other investigators in his own language. This, however, is a minor point. Passing to more important matters, we may proceed to enquire if the book really meets the want which has been stated to exist; and the answer to such an enquiry must depend on whether the good in it outweighs the bad, or the reverse. The features in the book which appear to be excellent, are, first, the evidence that a vast amount of pains has been expended in its compilation; and on those subjects to which the author has devoted research-work—the excretions, the blood gases and salts, and digestion—he is distinctly good, and men of science will be glad to have all Dr. Griffiths' experimental work in a handy form, instead of having to hunt it out from journals. Then the whole is exceedingly interesting, and will no doubt stimulate others to prosecute new work on the subject.

There is, however, much that must come in for adverse criticism, and the first point to which attention may be called is not so much the fault as the misfortune of the author in having to deal with a portion of biological science which is in an embryonic condition. Where little is known little can be said, and some of the chapters are little more than anatomy, with physiological excerpts from anatomical works. Again, on certain subjects such as muscular contraction and blood coagulation, the author is evidently not acquainted with the literature of his subject, and in other cases again there is internal evidence to show that Dr. Griffiths has not consulted original memoirs, but abstracts of them that have appeared elsewhere.

The main objection, however, that physiologists will feel about the work, is the conclusion to which they can hardly help coming, that Dr. Griffiths has not the advantage of being a physiologist; there is no wide grasp of the facts and hypotheses with which he has to deal, and the hand of the amateur is continually to be seen. Take as an instance the following sentences: "Urea is a product of *more or less* complete oxidation of *organic substances*, and is *formed in muscular tissues* by the *disintegration of the anatomical elements.* Uric acid on the other hand is the result of an incomplete oxidation, and is produced for the most part *in the blood*, or its equivalent when such fluid is *surcharged with peptones* which the tissues are unable to assimilate." (The italics are our own.) Again, in the chapter on the physiology of the sense organs, the difference between the tactile sense and general sensibility has not been apparently grasped; and even on subjects which the author has himself investigated, very often elementary facts have escaped him. Thus it appears that uric acid is the most constant of the nitrogenous metabolites in the invertebrata, but we are not in the majority of instances told how this insoluble substance is held in solution in an aqueous liquid. We also read that after starch has been digested with the secretion of the hepato-pancreas, it gives a precipitate of cuprous oxide with Trommer's test, and this is regarded as sufficient evidence of the formation of glucose. No reference is made to the fact that anylolytic ferments in the vertebrata produce maltose and not glucose from starch. Again, one would judge from Dr. Griffiths' words, that he regards the formation of leucine and tyrosine as the chief functions of a proteolytic ferment, or from the omission of hæmocyanin from the chapter on respiration that it was not a respiratory pigment, though this would be corrected by reference to the chapter on the blood.

Taking a general survey of the whole, we see that the book is far from perfect. Few books are when they first appear, and much that is faulty can be corrected in subsequent editions. We must, however, congratulate Dr. Griffiths on being the first to break new ground by producing a work on the subject, as well as on the good points that the book exhibits, and to which allusion has already been made.

W. D. H.

THE DESIGN OF RETAINING WALLS AND RESERVOIR DAMS.

A Text-Book on Retaining Walls and Masonry Dams. By Prof. Mansfield Merriman. (New York: John Wiley and Sons, 1892.)

BEFORE entering upon the investigation of retaining walls and their design, the author devotes two chapters to the consideration of earthwork slopes and the lateral pressure of earth. Owing to the changeable condition of earth under the influence of moisture, and the variable nature of any stratum, it is impossible to obtain strictly exact expressions for the forms of slopes of cuttings and embankments, or definitely accurate values for the lateral pressure of earth; but, nevertheless, the formulæ deduced by the author from general principles are useful in serving as a guide to correctness of design. It is indicated that theoretically an earthwork slope should be curved, becoming flatter towards the base; and though a straight slope is always adopted for cuttings and embankments, the curved form left by slips is somewhat in accord with this theory. The inclination of slopes must indeed depend on the nature of the soil, and must be flatter in made ground than in cuttings; whilst efficient drainage and protection of the surface of the slopes from the weather are equally important for ensuring stability.

The pressure of earth is the basis of all theoretical principles relating to retaining walls, and it has formed the subject of numerous experimental investigations in England and on the Continent which might have been advantageously referred to in this book. The author adopts the view that the pressure is normal to the back of the wall; but as this theory is not universally accepted, he has also obtained a formula for inclined pressure. A retaining wall may fail by sliding or rotation, and the masonry is assumed to be laid dry, owing to the uncertain amount of cohesion in mortar joints. In practice, however, retaining walls of any height are built with cement mortar; and sliding occurs at the base, or even sometimes on detached slippery surfaces of clay below the base; whilst rotation is due to excessive pressure on yielding foundations at the front of the wall. Stability largely depends upon the nature of the foundation and the backing behind the wall. A clay foundation is far less trustworthy than gravel, and sliding is most effectually prevented in slippery soils by carrying down the foundations well below the surface; whilst careless backing up with bad materials, not brought up in their layers, may push over the wall. Efficient drainage, moreover, at the back of the wall, and outlets for water at intervals through the wall to prevent its accumulation behind, are almost as important considerations as the design of the wall. A wall leaning over backwards is shown to be the most economical; but though this form might be adopted for building against an embankment, it would not be convenient for a wall built in a timbered trench to retain the side of a cutting. The four chapters relating to earthwork and retaining walls, which comprise the main portion of the book, will be very useful for practical engineers who desire to extend their theoretical knowledge on these subjects; but students should bear in mind that an almost exclusive treatment of the theoretical aspect of these questions must be supplemented in actual design by practical experience.

The theory of the strains on masonry dams, considered in the concluding chapter, is more precise, owing to the exactness of our knowledge of the laws of water pressure as compared with the uncertain and variable pressure of earth. The well-known condition of stability, that the lines of resultant pressures, with the reservoir empty and full, should fall within the middle third of the cross section, is explained, as well as the uncertainty which exists as to the actual distribution of the pressures throughout the dam. The lines of resultant pressures for any given section are easily obtained graphically, for the line of pressure with the reservoir empty is the locus of the centres of gravity of the sections above a series of base lines taken down the dam, and the actual pressure is the weight of these successive sections; whilst the line of pressure with the reservoir full is the modification produced in the former line by the addition of the water pressure at the successive depths. The theoretical section given on page 110 resembles the section of the Furens dam in France, the highest masonry dam hitherto erected, the form of which was determined by elaborate analytical calculations. The principles laid down concerning masonry dams require to be supplemented by two practical considerations, namely, that high masonry dams must be founded on solid rock to secure them against undermining and settlement, which would be fatal to their stability; and that their inner face should be coated with an inpervious material, to prevent the infiltration which otherwise takes place through their joints at great depths. In taking the pressure due to waves on the top three or four feet of the dam below the water as equivalent to the greatest observed pressure exerted by waves on the sea-coast, the author far exceeds the probable limit; for ocean waves, owing to the great extent of the exposure and the depth, are impelled with a much greater force than the waves of a comparatively small and sheltered reservoir. The additional strength given to a dam by arching it towards the reservoir is very properly neglected in the calculation of its stability, for besides being difficult to estimate precisely, this increase in strength is inappreciable in a long dam, and even in the short Furens dam the arched form was merely regarded as an extra safeguard.

The book is clearly and concisely written; it is illustrated by numerous diagrams in the text; and problems to be worked out are given at the end of most of the articles, each of which deals with a subject under a special heading.

OUR BOOK SHELF.

Directions for Collecting and Preserving Insects. By C. V. Riley. (Washington: Government Printing Office, 1892.)

DURING the last few years there has been in America a considerable increase of the number of persons interested in entomology. This may be due mainly to the fact that farmers have very practical reasons for studying insects, but no doubt it springs in part from a growing appreciation of the scientific aspects of the subject. However the increased interest is to be explained, one of its results is a constant demand, especially from correspondents of the U.S. Museum and the Department of Agriculture, for information as to how to collect, preserve, and mount insects. In the present work Mr. Riley undertakes to meet this demand. He also brings together a number of directions on points connected with such matters as the proper packing of insects for transmission through the mails or otherwise; labelling; methods of rearing; boxes and cabinets; and text-books. The work was prepared as a part of a Bulletin of the National Museum, but is also issued separately; and we need scarcely say that it is likely to be of great service to the class for whose benefit it was originally planned. Mr. Riley knows his subject so thoroughly that he is able to explain it simply and clearly, and the value of the text is enhanced by a large number of suitable illustrations. We may note that, in a paragraph on the scope and importance of entomology, he refers to various estimates of the number of insects in the world. Linnæus knew nearly 3000 species. In 1853 Dr. John Day thought there might be 250,000 species on the globe. Dr. Sharp's estimate thirty years later was between 500,000 and 1,000,000. In 1889 the estimate formed by Sharp and Walsingham reached nearly 2,000,000. Mr. Riley thinks even this estimate too low. Considering that species have been best worked up in the more temperate portions of the globe, that in the more tropical portions a vast number of species still remain to be characterized and named, that many portions of the globe are entomologically unexplored, and that even in the best worked-up regions by far the larger portion of the Micro-Hymenoptera and Micro-Diptera remain absolutely undescribed in our collections, and have been but very partially collected, he is of opinion that to say there are 10,000,000 species of insects in the world would be "a moderate estimate."

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Science and the State.

IN last week's NATURE I find the statement that I was allowed to leave the public service "without the slightest recognition" by the State.

However distasteful it may be to me to have anything to say on this subject, I feel bound, in justice both to Lord Salisbury's and to Mr. Gladstone's former Governments, to point out that it is incorrect. Very substantial recognition was awarded me by both; and the late Lord Iddesleigh, in offering to recommend me for a Civil List pension, expressly put it as an honour.

The distinction which the Queen has recently been pleased to confer upon me must therefore, I am afraid, be placed in the category of "unearned increments." T. H. HUXLEY.

Barmouth, Wales, August 30, 1892.

[We did not refer to such recognition as is implied in the granting of pensions. What we meant was that the State ought to have marked its appreciation of Prof. Huxley's great services by conferring on him some national distinction of the kind he has now received.—ED.]

An International Zoological Record.

ON this subject Mr. Minchin (NATURE, August 18, p. 367) writes as a Recorder, and he writes feelingly. Those who use Records can write with feeling too. The absurd waste of labour involved, even in the production of a single Record, by the present system is hardly to be excused by the consideration that the labour is voluntary. I say "voluntary" advisedly, for some three or four pounds is no pay for a month's hard work. And yet, for all this toil, the result, when, after a year or so of delay, we are presented with it, is notoriously unsatisfactory. It is indeed impossible for a single individual—often very far from acquainted with the subject he is recording—to work through all the scientific literature of the whole world for the preceding year, in search of some scattered references. Actually impossible, for the literature of one year never comes completely to hand before the end of the next, and perhaps not then; and this the Recorders seem to know, for many of them postpone their work till the autumn, though it should have already been published in the spring. The acceptance of Mr. Minchin's admirable suggestions would do away with the ridiculous decimiplication of labour, but it would neither make the Record complete nor hasten its publication. The public are probably more anxious for the latter results than they are for the relief of the Recorders.

Almost absolute completeness, a higher standard of work, and greater expedition, would probably be attained by some such organization as the following:—In each country a Bibliographer, possessing an all-round acquaintance with the subjects to be recorded; this bibliographer simply to record, on separate slips, titles and places of publication of papers issued in *his own* country (and therefore probably in his own language), and to mark by some symbol the groups of animals or facts alluded to in those papers. An Editor-in-chief, situated in some convenient postal and printing centre, *e.g.*, Naples, London, New York, Berlin, Paris, or Washington; this editor to govern the general plan of the Record, at present somewhat anarchic, to sort and distribute to specialists the slips which he receives from the bibliographers, and to edit the work. Lastly, for each group or division of a group, a Specialist, who, on receipt of the title-slips from the editor, should prepare the lists of new species, the abstracts of the papers, and a general review of advance in the subject. It may be pointed out that, by means of carbon-paper, title-slips can be easily written in duplicate or even triplicate; thus, by one writing of the bibliographer, slips can be prepared for the information of two or three specialists.

Such a scheme has the following advantages:—The literature is only gone through twice, instead of perhaps a dozen times. There is a possibility of completeness without much effort. Dates of publication can be ascertained with greater certitude. The quality of the work is improved by the employment of those specialists who will never consent to the colossal drudgery of the present system. Promptness of publication is possible. Thus, all slips for Europe and America could easily be sent to the editor within the first fortnight of the New Year, and by him transferred to specialists before the end of January. Literature from a greater distance would have to be sorted later on. Any specialist worthy of the name would already have seen most of the papers, and, with the help of abstracts from authors, could be ready with his manuscript before March, by which time the literature from the most distant parts would have come in and might be incorporated. The Record should go to press in separate divisions, so that the Birds need not be kept waiting because the Worms were not early; and the whole might well be issued in April or May.

The financial question must not be overlooked. As an International affair the sources of revenue of such a Record would be greatly increased. Not only Zoological and Royal, but also Geological Societies of all nations should be invited to contribute towards its expenses. The printer and the editor would have to be paid as now, the editor perhaps a trifle more. The postage would be a larger item, but postage is now so cheap that it really makes little difference. The bibliographers would of course have to be paid; but then the work of a bibliographer, even for the most prolific country, would be far less than the present work of the Recorder of, say, the Brachiopoda, who, I believe, gets about 30s. Some specialists would wish to be paid, but others would probably be satisfied by receiving the information from bibliographers and the abstracts and separate copies from authors. These latter, it is presumed, would gladly send single copies of their works for the use of a well-known specialist, but it is rather hard to have to distribute them to a dozen different Records, as one is requested to at present. The sale of such a work would be greater than that of the present incomplete and tardy publications. Besides, the promoters would doubtless be prepared to sell the various sections separately—an urgent reform that has long been clamoured for in vain; this alone would materially increase the receipts.

Having thought much of this subject during the last five years, and having talked it over with many Recorders and bibliographers, I venture to take this opportunity of putting forward the crude outlines of an undeveloped scheme. There is no wish to offend those unselfish toilers who have done and are doing so much for us, or the corporate bodies that support them. But this is a question that must be approached from a cosmopolitan standpoint. Men of science all the world over should support it with purse and person. All petty considerations of nationality, even of language, should be sunk. The aim of the work should be the advancement of science; only if it is truly International, can it possibly be realized out of Utopia. F. A. BATHER.

British Museum (Nat. Hist.), August 19.

PERHAPS you will kindly allow me, as the author of a certain pamphlet on "The Organization of Science," to say a few words on Mr. Minchin's letter (NATURE, August 18), which naturally had an especial interest for me. I am sorrowfully pleased to find the principles advocated in my pamphlet illustrated so well by concrete instance, and, needless to say, I heartily wish Mr. Minchin success in his endeavour to introduce order into at least one province of the scientific class, seeing that the text of my pamphlet may be exactly summed up in his remark—"A great need . . . is the intelligent *organization* of scientific research."

One point in Mr. Minchin's letter was of especial interest to me, for he invites the Royal Society to take in hand this work of organization, instead of leaving private individuals to execute at a great sacrifice the work which this wealthy corporation systematically neglects. Now a reference to my pamphlet (pp. 11-14) will show that this was a main thesis sustained there. Whether Mr. Minchin has done me the honour to read my pamphlet and is already preaching my crusade for me, or whether the similarity between our views is a simple coincidence of opinion, I know not, but whichever be the case, it is peculiarly gratifying to me to receive practically an endorsement from one whose experience renders him so especially qualified to speak with authority. A FREE LANCE.

London, August 23.

"The Limits of Animal Intelligence."

MR. DIXON has not, I think, quite grasped the main tendency of my paper read before the International Congress of Experimental Psychology. Nor is this to be wondered at. He quotes from a brief summary of what was itself but an abstract of a portion of a work on Comparative Psychology on which I am engaged. I am in agreement with nearly all that Mr. Dixon says, except where he misunderstands my position, and except in the opinion he expresses in the last sentence. When Mr. Dixon says, "Of course it is true that my knowledge of *my own* psychology does differ in kind from my knowledge of that of animals, but it differs in exactly the same way from that of all other men," he is expressing the views which I, in common with most men who have seriously studied the question, hold. And when he says, "If in no case is 'an animal activity to be interpreted as the outcome of the exercise of a higher psychical faculty if it can be fairly interpreted as the outcome of one which stands lower in the psychological scale,' the same rule should be applied to the (scientific) interpretation of human activities," I can only say that I heartily agree with him. Since, therefore, we have so much in common, I do not propose to occupy valuable space in discussing the outstanding points of difference between us. I may perhaps be allowed, however, to take advantage of the courtesy of the Editor of NATURE, and to say a few words in elucidation of the thesis I very imperfectly set forth in my paper, a thesis based entirely on observation and induction.

In the first place the study of my own mental processes, and of the nature and sequence of my own states of consciousness, has led me to the conclusion that there is a great difference between the mere feeling or awareness of certain relationships and the clear cognizing of these or other relationships. When I am bicycling, or playing tennis, or when I am living the practical life of naïve perception, I am aware of, and shape my actions in accordance with, a feeling of the relations which the objects of the external world bear to me and to each other. The greater part of my practical skill in action and of such intelligence as I show in meeting the emergencies that occur in my active life, are the outcome of this awareness of relations. But when I begin to attempt to *explain* phenomena, and to formulate my knowledge of the world, I find I am forced to pay special attention to these relationships *as such*, and to clearly and precisely cognize them. This conclusion, I repeat, is the outcome of observation, and is not, so far as I am aware, the result of any *a priori* considerations.

Looking back upon my own past, and collating the results with those reached by other observers, I find that the mere feeling or awareness of relations is prior in development to the clear and precise cognition of them. The awareness of relations seems to be, in fact, the undifferentiated germ from which their clear cognition has been developed; it is not knowledge, properly so called, but it is the raw material from which knowledge and the products of the intellect are shaped. Hence I conclude that the order of development or evolution in man is—first, the practical awareness of relations among phenomena, and then subsequently the cognition and clear knowledge (in the full sense of the word) of these relations as such.

Now, passing to the psychology of animals, such as the higher mammalia, the hypothesis suggests itself that they are still in the stage of mere awareness, and have not reached the stage of clear cognition, which, as I showed in my paper, involves reflection and introspection. This is put forward as an hypothesis; one based on observation and the doctrine of evolution; and one to be treated in the same spirit and on the same methods as other scientific hypotheses. It must be submitted to the touchstone of verification. The question is:—Are the activities of animals explicable on the supposition that the agents are merely aware of the relations; or must we suppose that they fully cognize them? I feel sure that my own practical activities are in the main based on awareness, and this leads me to suspect that the practical activities of animals are also of like psychological implication. The matter must, however, so far as is possible, be put to the test of experiment and observation. I have conducted from time to time experiments with the object of ascertaining how far there is evidence in the dog of true cognition—of causation for example. I am inclined to believe as the result of my observations that there is nothing beyond a simple awareness of the causal nexus. But I am far from wishing to dogmatize in the matter. I am chiefly concerned that the phenomena should be carefully observed, and that experiments should be conducted on definite scientific lines.

In conclusion I must be allowed to say that the phrases "difference in kind" and "difference of degree" savour somewhat of mere academic discussion, and may perhaps be left for those who deal with the matter on *a priori* lines and not from the standpoint of evolution. I for one do not for a moment question that the mental processes of man and of animals are alike products of evolution. The power of cognizing relations, reflection and introspection, appear to me to mark a new departure in evolution. But whether, as I am at present disposed to hold, the departure took place through the aid of language coincident with, or subsequent to, the human phase of evolution; or whether, as other observers and thinkers believe, it took place, or is now taking place, in the lower mammalia or in other animals, is a matter for calm, temperate, and impartial discussion founded on accurate, and, as far as possible, crucial experiment and observation. C. LLOYD MORGAN.

Rules of Nomenclature.

In your review of Mr. Massee's monograph of the Myxogastres (NATURE, p. 365) I notice the sentence, "Under the generally accepted rules of nomenclature, this leads to Massee standing as the authority for many species, transferred by him, in reality, to another genus." I take this to mean that, for example, a species of which the trivial name is, say, *abii*, and which was originally described by an author Xyz, and referred (erroneously) by him to the genus *Cdia*, has been transferred now to another (the correct, according to present knowledge) genus *Efia*, and the name is now printed in this work not as *Efia abii*, Xyz, but as *Efia abii*, Massee. I am aware that this course is frequently adopted, but surely not "under the generally accepted rules of nomenclature." There is no copy of the British Association "Rules" within reach here, but my recollection is that they prescribe a different course, viz., to retain as authority for a species the name of the original describer, and that is the course adopted in, I think, most of the *Challenger* reports, and by very many zoologists. I may state briefly as an example the first case that occurs to me—I have no systematic books here to refer to. (1) About 1870 Cunningham described a new Ascidian as *Cynthia gigantea*. (2) About 1880 Herdman transferred that species to the genus *Molgula*. (3) In the *Challenger* report this species figures as *Molgula gigantea*, Cunningham; and I would submit that that, rather than the course indicated in the review, is "under the generally accepted rules of nomenclature." W. A. HERDMAN.

Tarbert, Loch Fyne, August 23.

An Earthquake Investigation Committee.

IT may perhaps interest you and your readers to hear that by the Imperial ordinance of June 25 a committee has been established for the investigation of the earthquake phenomena, with the view of finding methods of predicting earthquakes, if possible, and of ascertaining the nature of construction, building, and otherwise, best calculated to resist the effect of the shocks. President Kato, of the Imperial University, has been nominated the president, and myself the secretary. Other members of the Committee are Furnichi (Director and Professor of Civil Engineering, Engineering College, and Head of the Engineering Bureau of the Department of the Interior), Tatonno (Professor of Architecture, Engineering College), Tanabe (Professor of Civil Engineering, Engineering College), Tanakadate (F.R.S.E., and Professor of Physics, Science College), and Nagaoka (Assistant Professor of Physics, Science College), Koto (Professor of Geology, Science College), and Kochibe (of the Geological Survey), Sekiya and Omori (Seismologists), Nakamura (of the Meteorological Bureau), and a foreign member, Prof. J. Milne Other members will be nominated by and by. The Parliament has granted 42,000 yen for this year, chiefly for the purchase of various instruments. The committee will be glad to receive any communication or suggestion on the subject. Address: Earthquake Investigation Committee, care of the Department of Education, Japan. D. KIKUCHI.

Imperial University, Tokyo, July 21.

Prehistoric Epochs.

I DO not think that the English authors who have written on prehistoric times have divided the Pleistocene in *epochs*, as Prof. G. de Mortillet has done in France. Would it be possible to use in England subdivisions similar, or almost similar, to those used in France, and almost generally adopted, although that classification is often subject to criticism?

According to Prof. G. de Mortillet, Palæolithic silex have been found in England that could be respectively related (1) to the type of Chelles or *Chelléen* (Hoxne, Biddenham); (2) to the type of the Moustier or *Mousterien* (Creswell, High Lodge); (3) to the type of Solutré or *Solutréen* (Creswell); (4) and to the type of La Madeleine or *Magdalénien* (Creswell, Kent's Hole). The same author says that at Creswell (Derbyshire) Palæolithic silex belonging to the *Moustérien*, *Solutréen*, and *Magdalénien* divisions have been found *in situ*, superposed as in the French stations, and according to him his classification could be adopted for the English prehistoric stations. Is that the opinion of the English authors who have most recently written on the matter, and is it possible to make a classification founded on the objects of the human prehistoric industry, parallel to the palæontological and stratigraphical classifications? EDMOND BORDAGE.

Muséum d'Histoire Naturelle de Paris, August 2.

At Portrush.

BEING on holiday (at Portrush) in the second week of August, I discovered growing on the sand dunes there the following species, bearing beautiful pure white blossoms. I found several patches of each:—

Thymus Serpyllum (wild thyme); *Prunella vulgaris* (self-heal); *Gentiana campestris* (field gentian); *Erica Tetralix* (cross-leaved heath).

Also the wild strawberry, bearing abundantly white fruit. Are these cases of reversion or of adaptability? Moths were very plentiful all over the dunes. JAMES RIGG.

18, Wilton Drive, Glasgow, Aug. 18.

Origin of Idea that Snakes Sting.

WILL you kindly inform me as to the origin of the idea that snakes sting? Froude, in "The English in Ireland," page 356, vol. i., writes: "The clergy started as if stung by a snake." Archdeacon Farrar, in "Darkness and Dawn," uses the metaphor of snakes stinging. Sir T. Browne ("Vulgar Errors") says "That snakes and vipers sting," &c., &c., "is not easily to be justified. It is not fair to bring in Shakespeare as to a matter of natural history. CYRIL FRAMPTON.

July 29.

ON THE RELATIVE CONTAMINATION OF THE WATER-SURFACE BY EQUAL QUANTITIES OF DIFFERENT SUBSTANCES.

THE experiments of Lord Rayleigh and Prof. Roentgen on the thickness of the invisible films of oil on contaminated water-surfaces led me to repeat these measurements by a somewhat different method, which may perhaps be worth describing, and at the same time to compare the contaminating effect of various substances.

In order to divide very small masses exactly I chose the course of Lord Rayleigh[1] of transferring the contaminating substance to the water-surface by means of a volatile solvent. But instead of ether I used *benzine*, and let the drops of the solution evaporate *directly from the water* instead of vaporizing them on a metal plate and then immersing this, as Lord Rayleigh did.

As a fixed condition of the water-surface Lord Rayleigh chose the tension when the movements of camphor fragments are stopped. Still more suitable for my purpose, however, I found another smaller degree of contamination, which is always to be fixed with great exactness. I mean *that degree at which the tension just begins to sink*. As I have already explained (NATURE, vol. xliii. No. 1115, p. 437) the sinking of tension does not begin gradually from the very commencement of contamination, but *abruptly*, when the latter has arrived at a certain value, and then the falling of tension takes place very rapidly. The state of constant tension I have called the normal and that of variable tension the anomalous condition.

My task was therefore to examine how much of a substance is required to make a surface of a given size enter the anomalous state or to find the area of a surface made anomalous by a given mass of the substance. The latter method was generally preferred, for it was more convenient to me.

The observations were made with the adjustable trough and balance[2] described in NATURE, March 12, 1891, p. 437, and were as follows:—

Of the substance to be tried 13 mg. were dissolved in 300 ccm. of benzol. Then the trough being filled with water and the surface made as clean as possible by sliding the partition all over the length of it several times, the solution was transferred to the surface in drops, each of which had a volume of 31 cmm. or about 1/9600 of the whole solution and thus contained 0·001354 mg. Four drops were introduced each time in order to equalize accidental irregularities of size. When the evaporation of the benzol was finished I diminished the length of the surface till it became anomalous, and this length was noted. Then immediately other four drops were introduced, again measured, and so on. After two or more observations the surface was cleaned anew, but generally the first length was observed to be a little too large on account of the imperfect purity of the surface.

A sufficient number of observations having been thus made, the original contamination of four drops of the benzol used was measured in the same way; by subtracting this from the contaminating effect of the solution I got the effect of the oil or other substance purposely dissolved.

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[1] Proc. of the Royal Society, 1890, vol. xlviii., No. 293, p. 127.

[2] For the purpose of actual measurements of surface-tension, I have constructed another instrument of larger dimensions; but to indicate only a slight variation of tension, any sensible balance with an adhering disc or wire-ring of any shape and size may be employed.

Thus with three solutions of Provence oil of equal concentration I got the length of the surface rendered anomalous by the oil contained in four drops:—

Solution I., 8·3cm.; Sol. II., 7·8cm.; Sol. III., 7·7cm.

For the sake of verification the other method, viz., counting the drops required for making the whole surface of the trough anomalous, was also employed. By this course the effect of four drops was obtained as follows:—

Solution I., 8·0cm.; Sol. II., 7·9cm.; Sol. III., 7·7cm.

The close agreement of the two methods proves that the strip of plate, simply laid across the trough, is sufficient to separate normal surfaces.

Another trial with an *ethereal* solution of olive-oil gave 7·1cm., if the somewhat different size of the drops be regarded; but I preferred benzine, because its original contamination was in most cases only between 1·3cm. and 2·5cm., whilst that of ether amounted to 4 to 6cm.

The mean of the lengths got by the three solutions was 7·9cm., and by this combined with the width of the trough = 5·8cm., we obtain the area of the surface made anomalous by 1mg. of Provence oil:

$$\frac{7{\cdot}9 . 5{\cdot}8}{4 . 0{\cdot}001354} = 8460 \text{ qcm.}$$

or a density of 0·000118mg. per qmm. at the beginning of the anomalous state.

In the following table are collected the results obtained with different substances:—

Substance.	qcm. per mg.	mg. per qcm.
Provence oil	8460 ...	0·000118
Ordinary olive oil ...	8565 ...	0·000117
Oleine [1]	8137 ...	0·000123
Rape-seed oil	7388 ...	0·000135
Poppy oil	8994 ...	0·000111
Tallow	9636 .	0·000104
Spermaceti	5568 ...	0·000179
Stearic acid	4711 ...	0·000212
Resin (colophony) ...	8105 ...	0·000123
Turpentine oil (clear) ..	107 ...	0·009346
Turpentine oil (older) ...	2944 ...	0·000339

The table shows next that the mass required for lowering the tension is not the same with different substances, and on the other hand it affords an interesting comparison between fluid and solid bodies. If the cause of the lowered tension be a film of greasy fluid spread over the surface, the contaminating effect of solid bodies can only be explained by small quantities of such fluids present on the surface or in the interior of the solid. This may be so in many cases, but the effect of stearic acid and spermaceti is such as if more than half their weight consisted of oil. The strong effect of colophony, although this did not dissolve entirely in benzine, and the result that tallow acts more strongly than an equal weight of oleine, its fluid component, also appear to me very remarkable.

After this it seems to me very probable that the contaminating substances *are not spread in coherent films at all*, but rather in a state of very fine distribution between the superficial water-molecules, that must be named either *emulsion* or *solution*.

However, only certain organic substances seem to be capable of forming surface-solutions of this kind, whilst the effect of metals and salts, formerly observed by me, was due to incomplete cleanness of the bodies, as later researches have proven.

Finally I will add some remarks on the thickness of the hypothetical oil-films. The thickness calculated from my observations with olive oil is at the beginning of the anomalous state 1·3 $\mu\mu$. In order to derive from this number the thickness at any other condition of the surface, it needs only to be multiplied with the relative contamination corresponding to that condition, that is, with the ratio of the surfaces. So we get at the smallest relative contamination measurable in my apparatus = $\frac{1}{35}$ a thickness of the film = $37 . 10^{-3}$ $\mu\mu$.

For measuring the relative contamination in the anomalous state, a special mode of procedure was required on account of the imperfect separation of surfaces by the partition. For that purpose I put on the surface that is to be contracted a [-shaped swimming wire, a little shorter than the width of the trough, and by the situation of this mark, following exactly every movement of the surface, I measured the relative length of the latter, instead of reading it from the partition itself.

The ratio in which the surface must be contracted in order to arrive at the tension at which camphor comes to rest, was very different with various substances, for an instance with stearic acid = $\frac{5}{3}$, oleine = $\frac{18}{11}$, ordinary olive oil = 5, and with Provence oil the tension in question could not be reached at all, except when the oil was standing on the water in visible drops or films. The calculated thickness of the film at the stopping of camphor movements would be with oleïn = 2·13 $\mu\mu$, ordinary olive oil = 6·5 $\mu\mu$, and with Provence oil still greater, if this liquid were spread equally. A very precise specification of the sort of oil used therefore appears to be necessary, if observations concerning this point are to be compared.

AGNES POCKELS.

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[1] A brown-looking liquid sold under this name in the drug stores.

NOTES.

THE Federated Institution of Mining Engineers will hold its annual general meeting in North Staffordshire on Wednesday, September 7, in the large hall of the First Shropshire and Staffordshire Artillery Volunteers, Shelton. Both on that and on the following day visits will be made to various works and places of interest.

THE Committee appointed to consider whether a national aquarium should be established in Sydney have presented a full and interesting report to Mr. F. B. Sutton, the New South Wales Minister for Public Instruction. They strongly recommend that "a commodious building of a substantial and not unsightly character" should be erected, to contain a large series of tanks constituting the public aquarium, with experimental tanks for researches on fish-breeding, &c., in connection with the fisheries of the colony, and laboratories for scientific investigation. It is calculated that the "initial cost" would be about £10,000, and that an annual amount of about £1200 would be needed for salaries and for purchases, repairs, and other incidental expenses.

IN response to an invitation from President G. Stanley Hall, of Clark University, a number of psychologists met from various institutions at that University, Worcester, Massachusetts, on July 8, for the purpose of forming an American Psychological Association. Prof. G. S. Fullerton, of the University of Pennsylvania, presided. After some general discussion on the form of organization the entire matter was referred to a committee. Sessions were held in the afternoon and evening, at which papers were read by Profs. Jastrow, Sanford, and Bryan, and Doctors Nichols, Krohn, and Gilman. It was decided in response to an invitation from Prof. Fullerton to hold the next meeting of the Association in Philadelphia, at the University of Pennsylvania, on Tuesday, December 27. Prof. Jastrow was appointed secretary to provide a programme for that meeting. He asked the co-operation of all members of the Association for the section of psychology at the Chicago Exhibition, and invited correspondence on the subject.

DR. VON LENDENFELD, at one time assistant to Prof. Lankester at University College, Gower Street, has been appointed to the chair of zoology at the University of Czernowitz, rendered vacant by the death of Prof. V. Graber.

PROF. DR. CHARLES BERG has become director of the National Museum at Buenos Ayres, in the place of Prof. Dr. Hermann Burmeister.

THE Council of the Institution of Civil Engineers has issued a list of subjects on which it invites original communications. The list, it is explained, is to be taken merely as suggestive, not in any sense as exhaustive. The Council points out that it has power to award to the authors of papers premiums arising out of special funds bequeathed for the purpose. No award will be made unless a communication of adequate merit is received, but more than one premium will be given if there are several deserving memoirs on the same subject.

THE twenty-third session of the German Anthropological Congress, which was held at Ulm early in August, was in every way most successful. At the first meeting one of the most prominent speakers was Prof. Ranke, who spoke of the need for a German National Museum. He recognized the value of the museums at Mainz and Nürnberg, but urged that a genuinely national institution ought to be established, and that the proper place for it is Berlin. At this meeting an interesting discussion on the so-called Kannstadt race was opened by Dr. von Hölder. The opinion of the meeting was that the characteristics of the famous Kannstadt skull are found in some persons of the present day, and that the skull is not one that has come down to us from prehistoric times. Prof. Virchow, who took part in the discussion, uttered a general warning as to the necessity for caution in attributing high antiquity to human remains. On the following day a paper on the anthropological position of the Jews was read by Dr. von Luschau. His main points were that the Jews are a mixed race, and that in some of their physical peculiarities (such as the form of the nose) they resemble the Armenians more closely than any people of purely Semitic origin. Prof. Kollmann dealt with the question of the origin of the European peoples, and Prof. Virchow spoke of the fact that the traveller Vaughan Stevens has found in the interior of Malacca a genuine Negrito stock, and has sent skulls and specimens of hair. At the third meeting one of the best papers was by Dr. Boas, on the organization of anthropological research in North America. It was decided at this meeting that the next session of the Congress would be held at Hanover in 1893. Scientific excursions were made to Blaubeuren and Schussenried, where traces of lake dwellings have been discovered, and to Sigmaringen and Schaffhausen.

THE causes of the St. Gervais disaster are being gradually elucidated. A very interesting paper describing a visit to the small Téte-Rousse Glacier is contributed to *La Nature* (August 20) by M. Vallot, director of the new Mont Blanc Observatory. At the end of the glacier, on a steep face of rock, he and M. Delebuque found an enormous arching cavity, filled recently (it would appear) with ice which had been shot out by some internal force. They entered the cavern, and observed traces of an interior lake. A passage, strewn and overhung with blocks of ice, led up to an open space, a sort of huge crater, with walls of white ice, absolutely vertical. It was about 270 feet long, and 133 feet broad and deep. M. Vallot and his friend returned by the way they entered, and examined this crater from above. Their opinion is that a lake had been formed at the bottom of the glacier, and the crater, gradually accumulating through obstruction of the orifice of outflow, had undermined the ice-crust over the upper cavity. This at length collapsed, exerting enormous pressure on the water, which pressure, transmitted to the lower grotto, burst the glacier, throwing out the anterior part on the steep rocky slope. Thus is explained the enormous quantity of water precipitated into the valley, carrying in its passage the soil of the banks, and forming a torrent of liquid mud mixed with ice blocks and rocks. M. Vallot estimates that about 100,000 cubic metres of water and 90,000 of ice issued from the glacier. On reaching the Baths the torrent may have been 300,000 cubic metres. He supposes that the sub-glacial lake may form again, and the remedy would be to blast the rocky bottom so as to provide an escape for the water; a work which should be done speedily to be of use.

THE weather has been very unsettled during the past week, several low-pressure systems having passed over our islands from the westward, accompanied by very heavy rain, especially in the southern, northern, and western parts of the country. Between mid-day of Saturday and Sunday $1\frac{3}{4}$ inches fell in the south, being about three-fourths of the average fall for the month of August, and another heavy downpour occurred in the north and west on Monday night, two inches being measured in the west of Scotland, and $1\frac{1}{2}$ inches at Holyhead. The temperature has fallen considerably since the previous week, the daily maxima rarely exceeding 70° in the southern parts of the country, while in the north and west it has been considerably lower. The wind has reached the force of a gale on the coasts on more than one occasion during the week, and on Tuesday the centre of a rather deep depression lay over Ireland, while the sea was rough on nearly all coasts, the conditions being very threatening, with a prospect of further heavy rains. In southwest England the amount of rainfall from the beginning of the year up the week ending August 27th, was still more than eight inches below the average, and the only district where the amount just exceeded the average was the northern part of Ireland.

THE New England Meteorological Society has issued a volume of Investigations for the year 1890 (reprinted from the Annals of Harvard College Observatory, Vol. xxxi. pt. I., 1892) containing a summary of the observations made at the Society's stations; reports were received from 172 observers during the year, also five-year tables of temperature and precipitation, by J. Warren Smith, with an introduction by W. M. Davis, Director of the Society. The title scarcely explains the real amount of work done, for at some stations there are many periods of five years, *e.g.*, at New Bedford (Mass.) the observations extend over 15 pentades (1816–1890). It has not been possible to keep to the same years in all cases, nor has any attempt yet been made to discuss the data.—The tornado at St. Lawrence (Mass.), of July 26, 1890, by Helen Clayton. This storm caused considerable loss of life and property. The distances between the points where destruction was reported seem to indicate that the destructive winds descended at times to the earth's surface at certain points, and after a short track rose again. Prof. Davis has written a preface to this paper, in which he discusses fully the characteristics of tornados.

THE Annual Report on the Royal Botanic Gardens, Trinidad, for 1891, contains a table showing the monthly and yearly rainfall values for thirty years ending 1891. The average yearly fall for that period was 65·91 inches. Mr. F. H. Hart points out that the rainfall shows a decrease at a seriously rapid rate, for, dividing the period into decades, the first decade shows a total of 7·12 inches more than the second, and the third shows another decrease of 9·56 inches on the second, or 16·68 inches on the first decade. This is a subject of the utmost importance to questions of forestry and water supply. He also points out that the rainfall is not so much affected as is generally supposed by the contiguity of Trinidad to the mainland, but more particularly to the course of the trade-winds which blow towards the continent of South America. It is a curious fact that it always rains at Trinidad with a high barometer. On June 25 last the observer states that it was not daylight until long past the proper hour, the readings at 9h. a.m. having to be taken by candle-light. The rain was heavy and continuous, and was accompanied by the *highest* barometer readings for the year.

"FIFTY Years of York Meteorology, 1841–1890," a paper contributed to the report of the Yorkshire Philosophical Society for 1891, by Mr. J. Edmund Clark, has been issued in pamphlet form.

SOME of the effects of the absence of light upon animal life were strikingly revealed, not long ago, on the reopening of an old mine near Bangor, Cal. In a dry slope connecting two shafts, one of the explorers was astonished to find a number of flies that were perfectly white, except the eyes, which were red; and directly afterwards he killed a pure white rattlesnake. The animals had lived in the dry passages, where they had been supplied with air but not with light. It is supposed that the flies were the offspring of some that had been imprisoned by the partial filling of the mine with water about thirty years ago, and that the snake, when quite young, had been washed down in a rain. A few of the flies were exposed to light in a glass case, and resumed the colours of ordinary house flies within a week.

A WHALING party is being fitted out in America for the purpose of obtaining a live whale for exhibition in the Fisheries department at the World's Fair at Chicago. If captured the whale will be confined in a tank and towed to Chicago by the way of the St. Lawrence river.

IT would appear that naphtha is poisoning the Volga, doing great injury to the fishing industry. Dr. Grimm says (*Messager des Pêcheries*) that the quantity of naphtha conveyed on the river rose from some 32 million kilogrammes in 1887 to nearly 50 millions in 1889. Most of this is carried in badly-made wooden barges, and there is a great deal of leakage into the river, about 3 per cent. on an average (it is estimated). Thus in the three years, 1887 to 1890, the Volga must have absorbed some three million kilogrammes of naphtha, without reckoning petroleum, of which there is a considerable (though less) leakage. Everywhere the fish are decreasing, and they quite disappear at places where boats stop. On the other hand, various fishes—the starlet of Astrachan, *e.g.*—living in the infected water, get a flavour of naphtha, and are no longer eatable. The naphtha also kills the infusoria, insects, flies, mosquitoes, &c., which serve as food for the fishes. In its spring floods the river spreads naphtha over the meadows, destroying the larvæ of those organisms. The thin layer of naphtha on the water hinders the larvæ from breathing. Further, the naphtha injures the vegetation in the meadows. Naphtha is found in such quantities on the land as to suffice for domestic use to the natives, who collect it. Dr. Grimm urges the necessity of taking steps to prevent the ruin of the Volga fisheries.

AMONG the most interesting Echinoderms collected by the United States Fish Commission steamer *Albatross*, on her voyage from New York to San Francisco, was a stalked Crinoid, which is described in No. 2, vol. xvii., of the Memoirs of the Museum of Comparative Zoology at Harvard College (January 1892). The material, consisting of portions of three specimens, was dredged in 392 fathoms off Indefatigable Island, one of the Galapagos group. During the last dredging trip of the *Albatross* an additional specimen was obtained off Mariato Point, in 782 fathoms. When this last specimen was taken out of the water it was of a brilliant lemon colour, with a greenish tinge on the sides of the arms and along the food furrows of the ventral surface. A coloured sketch of it is given from a drawing made on the spot by Mr. Westergren. Its base of attachment came up with a fragment of stem nearly 14 inches long. At the first glance Prof. Agassiz was inclined to regard it as a modern representative of Apiocrinus, but a more careful examination showed so many points of difference that he had to establish the new genus Calamocrinus for its reception, and it stands as *C. Diomedæ.* It is most closely allied to a large group of Mesozoic Crinoids, and it assists in making clear many points in their morphology. This genus has the orals greatly reduced, much as in Bathycrinus. It also possesses heavy perisomic plates, passing gradually into still stouter so-called interradial plates, in Calamocrinus, in no wise to be distinguished from the true interradials of Palæozoic Crinoids. Another structural feature is the limitation of the articular facet to the middle of the radial. This is an eminently embryonic character, and there are traces of it in some of the forms of Millericrinus described by De Loriol in his Jurassic Crinoids, especially in *M. milleri.* After a very detailed and masterly description of the stem, calyx, and arms of the species, Prof. Agassiz discusses the subject of the "Apical System of the Echinoderms," and "Of some of the Homologies of the Echinoderms." Thirty-two plates, some coloured, accompany this Memoir, which is inscribed as follows: "From the time the Crinoids which form the subject of this Memoir came into my hands, I have been in constant correspondence with my late friend, Philip Herbert Carpenter, regarding the many points of interest suggested by their discovery. I can now only have the melancholy satisfaction of inscribing to his memory a Monograph which I had hoped to dedicate to him as an expression of my admiration for his researches in a field where we had long been fellow workers."

M. DE LAPOUGE calls attention, in *La Nature*, to an interesting object he has found in one of a number of ancient graves he has been excavating at Gignac (Hérault). It is a finely-carved head of jade, representing a type of the yellow race. It evidently formed part of a statuette of a religious character, and the style shows that it must have come either from China or Japan. M. Sindhô is of opinion that the statuette was probably made in Japan a little before the Christian era, from a Hindu or Sinhalese model of Buddha. M. de Milloué thinks the head is that of Kouan Yin, a Chinese divinity, while M. de Rosny and M. Motoyosi attribute it to Mayadêvi, the mother of the founder of Buddhism. Whatever the object may be, M. de Lapouge is inclined to believe that it hung as an amulet around the neck of a Hun or Goth, and that the graves at Gignac belong to a cemetery of a West Gothic colony.

A VALUABLE essay on the Ainos of Yezo, by Mr. Romyn Hitchcock, is included in the report of the U.S. Museum for 1890, and has just been issued separately. It is based mainly on the author's personal observations. He has much that is interesting to say on the various aspects of the life of the Ainos, and his remarks are admirably illustrated. Mr. Hitchcock notes the remarkable fact that the Ainos have been very little influenced by the civilization of the Japanese, with whom they have so long been in close contiguity. The Aino, he says, has not so much as learned to make a reputable bow and arrow. Unable to affiliate with the Japanese, the Ainos "remain distinct and apart," and for that reason, in Mr. Hitchcock's opinion, are "doomed to extinction from the face of the earth."

THE second volume of Mr. J. Walter Fewkes's "Journal of American Ethnology and Archæology," has just been issued. The most important article in the first volume was an interesting account, by Mr. Fewkes, of "a few summer ceremonials at Zuñi Pueblo." The greater part of the second volume is devoted to a description, by the same writer of "a few summer ceremonials at the Tusayan Pueblos." Mr. Fewkes and his assistant, Mr. J. G. Owens, were admitted as priests by the Tusayans, so that the paper contains many details which have not hitherto been accessible to students. Mr. Fewkes also presents a report on the present condition of a ruin in Arizona called Casa Grande, and Mr. Owens describes various natal ceremonies of the Hopi Indians.

THE new number of the *Internationales Archiv für Ethnographie* (Band V., Heft 3) opens with a paper, in French, by M. G. van Vloten, on the flags used at Teheran in connection with the festival in memory of the martyrdom of the Imâm Huçeïn. M. Désiré Pector contributes (also in French) some observations suggested to him by the reading of a work by M. de Montessus on Pre-Columbian Salvador. Herr F. Grabowsky writes (in German) on the theogeny of the Dayaks.

THE following are the subjects of papers in the current number of the *Mineralogical Magazine*:—Minerals from the apatite-bearing veins at Noerestad, near Risör, on the south-east coast of Norway, by R. H. Solly (with a note on their occurrence, by A. L. Collins); on the pinite of Breage in Cornwall, by J. H. Collins; danalite from Cornwall, by H. A. Miers and G. T. Prior; mineralogical notes from Torreon, State of Chihuahua, Mexico, by Henry F. Collins; note on crystals of manganite from Harzgerode, by Frank Rutley; analysis of aragonite from Shetland, by J. Stuart Thomson; orpiment, by H. A. Miers. There are also reviews and abstracts; and Mr. Miers and Mr. Prior contribute a valuable index to mineralogical and petrographical papers, 1888.

WE have received from the Geological and Natural History Survey of Canada, Part 4 of "Contributions to Canadian Micro-Palæontology." The report consists of descriptions and illustrations of thirteen new and three previously known species of Radiolaria, collected by officers of the survey from the upper cretaceous rocks of North Western Manitoba, and has been prepared for publication by Dr. D. Rüst, of Hanover. Mr. Tyrrell, geologist in charge of the explorations in Manitoba, contributes a short introduction to the report.

BULLETIN No. 11 of the Imperial University College of Agriculture, Komaba, Tōkyō, has recently been published. It consists of the report of Dr. O. Kellner on the third year's "Manuring Experiments with Paddy Rice."

AMONG the contents of the June number of *Temehri*, the Journal of the Royal Agricultural and Commercial Society of New Guinea, are papers on "Twenty Years' Improvements in Demerara Sugar Production" (Part 2), "The Bats of British Guiana," "Guiana Gold," and "Our Birds of Prey." The number also contains many short notes of an interesting nature.

MR. S. GARMAN publishes a treatise on the fishes of the families Cyclopteridæ, Liparopsidæ, and Liparididæ, in the Memoirs of the Museum of Comparative Zoology at Harvard College (Vol. xiv., No. 2, April 1892). Though several of the rarer forms of Discoboli are not represented in the collections of the Harvard Museum, yet it possesses so many duplicates of several species, in addition to rare and some undescribed types of others, that it presented great facilities for a study of the group, of which Mr. Garman has well availed himself. Prof. F. W. Putnam had at one time intended to write a history of the group, and many drawings had been some years ago prepared for it by Mr. Roetter; these drawings have been utilized in the present memoir, and the work has been made more complete by the drawings of the young stages of several of the species, contributed by Prof. A. Agassiz. After a short introduction there is a history of the distribution of the species, followed by one on the history of the genera from the times of Pliny, Gesner, and others, and then a description of the recognized genera and species, of which the following is a summary. *Cyclopterus lumpus*, Linn.; *Eumicrotremus spinosus*, Mull.; *E. orbis*, Gthr.; *Cyclopteroides gyrinops*, gen. et spec. nov. (St. Paul's Island, Alaska); *Cyclopterichthys ventricosus*, Pall.; *C. amissus*, Vaill.; *Liparops*, gen. nov. established for *Cyclopterus stelleri*, Pall.; *Liparis montagui*, Don.; *L. mucosus*, Ayr.; *L. calliodon*, Pall.; *L. liparis*, Linn.; *L. antarctica*, Put.; *L. agassizii*, Put.; *L. tunicatus*, Reinh.: *L. steineni*, Fisch.; *L. pulchellus*, Ayr.; *L. pallidus*, Vaill.; *Careproctus micropus*, Gthr.; *C. major*, Fabr.; *C. gelatinosus*, Pall., *C. reinhardi*, Kroy.; *Paraliparis rosaceus*, Gilb.; *P. bathybius*, Col.; *P. liparinus*, Goode; and *P. membranaceus* Gthr. *Careproctus longifilis*, spec. nov., and *Paraliparis fimbriatus*, spec. nov., are also indicated, but will be described at length in the forthcoming report of the "U. S. Fishery Commission."

SOME experiments have recently been made at the New York Agricultural Experiment Station upon the possible effect of long-continued applications of a copper sulphate spray used as a fungicide (Bulletin 41). Two soil mixtures were used, one containing 5 per cent. and the other 2 per cent. of copper sulphate. These quantities are comparatively so enormous that useful practical conclusions cannot yet be drawn, though some of the results have proved interesting. Seeds of plants representing widely differing natural orders were planted in these soils, and at the same time an equal number of the same kinds of seeds were planted for checks in similar soil to which no copper sulphate was added. Care was taken to select good seed, and to give the soil mixtures, and checks exactly similar conditions and treatment. In the soils containing sulphate of copper more seeds germinated in almost every case than in the soils containing no copper. The average length of time required for germination was greatest in the copper soils. The foliage of plants grown in the copper soils was of a deeper green and darker with the 5 per cent. soil mixture than with the 2 per cent. one, but although darker the leaves were smaller and the height of the plants and the yield of fruit very much less than in the case of plants grown under normal conditions. Peas grown in the 2 per cent. soil mixture seemed to be more vigorous for the first few weeks than the check plants grown in untreated soil; they also came to maturity earlier, but finally showed a dwarfed appearance, and the yield was less than with the check plants, being little more than one-half the yield under normal conditions. In the 5 per cent. soil mixture peas gave a yield only one-seventh of that from untreated soil. In the case of all plants grown in the soil mixtures the roots were very small and ill-developed. Analysis of the tops of tomatoes grown in the 5 per cent. soil showed in the air-dried substance ·06 per cent. of copper, proving conclusively that these plants can take up sulphate of copper by their roots. Analyses were made of berries and stems from vines which had been sprayed with copper compounds, and although the amount of copper found upon the stems varied, that found on the grapes was practically constant, and amounted to 1/120th of a grain per pound of grapes, this quantity being considered quite negligeable and harmless.

THE additions to the Zoological Society's Gardens during the past week include two Rhesus Monkeys ♂ ♀ (*Macacus rhesus*) from India, presented by Mr. J. Hall-Browne and Mr. Rivers respectively; four Virginian Foxes (*Canis virginianus*) from California, presented by Mr. Edward Chauvenet Holden; two Ogilby's Rat Kangaroos (*Hypsiprymnus ogilbyi*) from Australia, presented by Mr. John W. Roche; a Ruffed Lemur (*Lemur varius*) from Madagascar, deposited by Captain Marshall, F.Z.S.; three Tigers ♂ ♀ ♀ (*Felis tigris*) from India, deposited by Messrs. William Watson and Co.; a Blue and Yellow Macaw (*Ara avarauna*) from South America, presented by Mr. R. Larchin; ten Spanish Blue Magpies (*Cyanopolius cooki*), and two Ravens (*Corvus corax*) from Spain, deposited by Lord Lilford, F.Z.S.; two Fringed Chameleons (*Chamæleon tæniobronchus*) and a Lobed Chameleon (*Chamæleon parvilobus*) from Natal, presented by Mr. Charles W. Heaton; a Black Iguana (*Metopoceros cornutus*) from West Indies, purchased; six African Scorpions (*Scorpio*, sp.inc.) from South Africa, presented by Mr. J. F. Hawtayne.

OUR ASTRONOMICAL COLUMN.

PHOTOGRAPHIC MAGNITUDES OF NOVA AURIGÆ.—*Astronomical Journal*, No. 269, contains the results of Mr. J. M. Schaeberle's work with regard to the determination of the photographic magnitudes of stars, including also that of Nova Aurigæ. The method he has adopted differs from those used by former observers in that the photographic magnitude of a star for any exposure-time is expressed "as a function of the equivalent theoretical aperture which a standard star (Polaris in this case) would require to make the same impression on the plate in the same time." The particular form which the expression, as obtained from this investigation, assumes enables one, after having once adopted the photographic magnitude of the standard star, to determine the theoretical photographic magnitude of any other star without any reference at all to the visual magnitude. As this method had only been applied to bright stars, the appearance of Nova Aurigæ suggested a further trial for stars of less magnitude which were visible only in large instruments. On the plates, which were each night exposed, three stars in the region of the Nova, the images of which resembled somewhat that of the Nova in form, size, and density, were selected for the sake of comparison. The magnitudes of these comparison stars were then determined by direct measurement of their images on the standard positive plate, this plate being a second positive from the original negative. The resulting photographic magnitudes for the month of February showed that the light of this new star fluctuated very considerably, confirming the visual observations.

The following list gives the theoretical magnitudes as obtained in this way, the mean time at Mount Hamilton being also added. The exposures up to March 10 were all moderately short, varying from 2 to 128 seconds.

Date 1892.	Mt. Hamilton M.T.	Mag.	Date 1892.	Mt. Hamilton M.T.	Mag.
	h. m.			h. m.	
Feb. 6	12 30	4·63	Mar. 2	10 45	5·20
8	7 20	4·54	3	9 10	5·09
9	9 40	4·67	4	8 25	5·63
10	10 7	4·77	6	9 15	5·40
11	8 55	4·4	7	9 40	5·90
12	7 20	4·5	8	9 10	6·09
13	9 20	4·3	9	8 55	6·16
14	7 40	4·03	10	8 ±	7·10
15	6 15	5·22	11	8 ±	7·70
21	10 10	4·96	13	8 24	7·70
22	9 30	5·12	15	11 9	8·45
24	7 ±	4·84	16	8 35	8·60
25	8 55	4·90	20	8 56	9·25
26	9 50	5·04	21	8 50	9·40
27	8 20	4·75	22	9 17	9·55
28	8 50	4·98	24	9 2	9·80
			25	9 10	10·00

COMPARISON STARS OF THE PLANET VICTORIA.—Dr. Gill, in *Astronomische Nachrichten*, Nos. 3107-08, communicates an article on the definite places of the stars used for comparison with the planet Victoria in the observations for parallax made in the year 1889. The positions of these stars are now, as he says, "more accurately known than those of any other group of stars in the heavens," and he suggests that they should be advantageously used for the determination of optical distortion and scale values of photographic telescopes, and for testing the various methods for the "raccordement des plaques." The positions of the thirty-seven stars are based on 3766 meridian observations of right ascension, and 3771 meridian observations of declination, together with several other observations made with the heliometers at the Cape, Yale, and Göttingen, amounting to 1867 measurements of distances, and 151 position angles. In the first tables which Dr. Gill here gives, are shown the definite places for the Victorian comparison stars computed for the Equinox 1889·90, and Epoch 1889·55. Owing to the comparatively large quantities that the probable errors of the proper motions amount to, Dr. Gill mentions that it is desirable to obtain photographs for determining scale-value distortion, &c., as soon as possible. Table 2 consists of a comparison between the distances as obtained from definite co-ordinates, and these as measured by Gill, Finlay, Jacoby, Chase, Schur, and Ambronn with the heliometer.

INTERNATIONAL TIME.—In a small pamphlet, published by Mr. Edward Stanford, a scheme for a systematic regulation of time is discussed by Major the Hon. E. Noel. The principle on which the system he proposes is based is the same as that which is at present in use on the American continent. It consists in dividing the earth's surface up into time-zones each covering fifteen degrees, so that they will differ from one another by one hour. In considering the question of the initial-time meridian, there are many points which have to be well borne in mind. In the first instance there must be a first-class observatory, on which every one could depend; secondly, the contra-meridian, *i.e.*, that half of the initial meridian in the opposite hemisphere, must fall in a convenient place, by which is meant that it must not cut through a continent or any large tract of land. Another important consideration is the arrangement of the time-zones, which must, if possible, be conveniently related to the longitude boundaries as are shown in our maps. Taking these points into account, Major Noel retains Greenwich as the initial for longitude, but selects Rome as our initial for time. On this basis he discusses this scheme with reference to each individual country. The only great country which this arrangement would not suit is France, for she, as is well known, keeps Paris time; a suggestion put forward here is that France should form a special zone, making her time exactly, instead of approximately, forty minutes after Rome. The folding diagram which accompanies this pamphlet shows a map of the world graduated on this system. From this one sees that the meridian of Rome traverses the centre of the Scandinavian Peninsula, coincides with Copenhagen, passes close to Leipzig, and between Berlin and Munich, while it cuts Italy from north to south. The western boundary of this zone, which is exactly on the fifth meridian west of Greenwich, passes between Italy and Spain, outside the western frontier of Germany, and skirts the west coast of Norway, while the eastern boundary also traverses convenient points for such a division of time. In considering the scheme as a whole, there is much to be said in its favour; but as such a question as this deals with so many nations, its development and final adoption cannot take place in a trice, but can only be brought to a head after many years' deliberation and debate.

COMET SWIFT (MARCH 6, 1892).—The ephemeris of Comet Swift is given in *Edinburgh Circular*, No. 29, and has been computed from elliptic elements supplied by Herr Berberich. This comet in large telescopes is quite a conspicuous object, while in smaller ones it is still visible. The following ephemeris we take from the above-mentioned source:—

Ephemeris for Berlin Midnight.

1892.	R.A.	Decl.	Log Δ.	Log r.	Br.
	h. m. s.	° ′			
Aug. 31	0 42 35	+52 42·6			
Sept. 1	41 24	38·3			
,, 2	40 10	33·6	0·2693	0·3922	0·081
,, 3	38 55	28·5			
,, 4	37 39	22·9			
,, 5	36 22	16·9			
,, 6	35 4	10·5	0·2720	0·4004	0·077
,, 7	0 33 46	52 3·7			

Taking the comet's position for September 2, we find that it will lie very nearly 3½° south of α Cassiopeiæ, being in the prolongation of a line joining the stars λ and ζ of the same constellation.

GEOGRAPHICAL NOTES.

THE Berlin Geographical Society are preparing for publication one of the most valuable mementoes of the Columbus celebration, in the form of a magnificent atlas, containing amongst other early maps a series of hitherto unpublished delineations of the Atlantic of very early date. These maps have been discovered in manuscript in Italian libraries, where they were copied by a young German geographer of great artistic power. They will be published with all the brilliant colouring of the original illuminated MSS.

IN the recent risings of the Arabs against European traders and officials on the Lomami in the Congo Free State, there is too much reason to fear that the veteran M. Hodister, Director of the Katanga Company in Africa, has lost his life. This is a disaster of a much more serious kind than the mere collapse of a trading company, for M. Hodister in the course of his long service in Central Africa had acquired a remarkable knowledge of the Arabs, and great tact and success in dealing with them. In his personal character he commanded the respect of all with whom he came in contact; courage he shared with many fellow-explorers, but his calmness in danger and serious earnestness in work are not too common amongst the Congo State officials or the leaders of caravans through the territory. M. Hodister was one of the first Belgian officers appointed on the establishment of the Congo Free State, and as an official, and later as the head of the Katanga syndicate in Africa, he has spent the best years of his life in opening up the Congo Basin.

THE Sixth International Geographical Congress having been fixed to meet at London in June, 1895, an organizing committee, of which Major Leonard Darwin is President, and Mr. J. Scott Keltie Secretary, has been appointed by the Council of the Royal Geographical Society. Circulars have been sent out calling attention to the fact that the meeting is to take place, and inviting suggestions. A provisional programme of the proceedings will be drawn up in the course of next year.

AN exhaustive bibliography of Socotra has just been published as a pamphlet of forty pages by M. James Jackson, the librarian of the Paris Geographical Society. Including references to maps, there are 176 entries relating to this island; many of these papers had almost passed into oblivion, and their recovery and systematic presentation is of much value.

SOME PROBLEMS IN THE OLD ASTRONOMY.[1]

IF a comparison were instituted between the position of the modern astronomer and that of his prototype on the plains of Chaldea, it would not be altogether to the disadvantage of the ancient student of the heavens. He stood at the gateway of the unexplored Uranian mysteries, unfettered by the dogmatic theories of a line of predecessors. From his own imagination he constructed hypotheses and theories, with no feeling of uncertainty about the priority of invention, and with little anxiety concerning the agreement of theory and observation. The modern questions that distract the astronomical world had no place among the thoughts that disturbed the tranquillity of his soul. He had not reached that critical epoch when he must choose between the "old" and the "new" astronomy; and he was free from the harassing perplexity that besets the luckless astronomer of this age who seeks to learn the mysteries of the moon's motion, or strives to formulate the cause and the law of the variation in the terrestrial latitude. The iniquitous behaviour of the astronomical clock and level, combined with the possible, but unknown, influences of temperature, were not then in league to vex his waking hours and fill his dreams with illusory solutions that ever floated just beyond his grasp. He was not obliged to search the ancient records in musty volumes and strain the limits of conjecture in the interpretation of careless observations and imperfect memoranda; in short, he was a happy man, free to work in any direction, and not liable to be called upon from time to time to amuse or to instruct his fellows, or even to weary them, with prosy discourse on his own work or a stale *résumé* of astronomical progress.

Unfortunately for us, we live in an age when astronomy is no longer a simple subject, stimulating the imagination by the nightly display of stellar and planetary glories, and involving in its study only the elements of geometrical analysis. Within the last fifty years the science has been separated into many divisions; and within a few years several of these branches have assumed new phases. As a result of this continued division, the range of study and investigation has spread beyond the efficient grasp of any individual, and specialists are rising up in all directions.

It has been the custom for the presiding officer of this section to present, on the first day of the annual session, an address setting forth either the progress in general astronomy or in some branch of the science, or the history or development of some department of mathematics, each confining himself to his own special branch of scientific work.

It has seemed to me that a formal statement, to this section, of the general progress of astronomy within the last year or the last decade, would be to lay before you a mass of data with which you are already familiar. This view of the case has led me to attempt the presentation of the importance of one branch of astronomical work in which for several years I have taken a deep personal interest, and which, owing to the present tendency towards specialization, is likely to suffer from serious neglect.

It is not many years since we first heard of the distinction between the "old" and the "new" astronomy, but in the comparatively short interval since those terms were first used the scope of physics has so expanded in all directions and so adapted itself to its new surroundings that we find it, in one department at least, casting aside its former title and masquerading under the name of astronomy. That this departure has quickened the zeal of many students, stimulated the development of numerous and valuable modes of research, and resulted in grand and important discoveries, is one of the most gratifying scientific facts of this epoch. The direction of this new movement has followed rigorously the line of least resistance. Except in rare instances, that line of work which promises the quickest returns in the proper form for publication is most attractive to the young student of physics and astronomy, and the comparatively inexpensive apparatus required for the simpler astro-physical work is apt to lead him in that direction. The new and important changes that have been wrought within a few years in the methods of teaching and in the laboratory work in physics, together with the apparent ease with which an account of a few hours' labour with the spectroscope or camera may be spread attractively over several printed pages, have doubtless had their influence in leading the candidates for honours into the new fields of astro-physical research.

The advance in the development of methods of research and the improvements in apparatus are so rapid, and the field is so broad and increasing, that constant vigilance is necessary to keep even in touch with the progress of the "new" astronomy. One of the most striking examples of the achievements in this new line of work has resulted from a skilful combination of the spectroscope and the camera in the determination of stellar motion in the line of sight with a remarkable linear exactness.

The limits of this address would scarcely suffice to simply name the problems now under discussion by the more modern methods, without essaying even a cursory review of their importance or their bearing on current scientific investigation; and yet, from the true astronomical point of view, all of these questions are at least secondary to the fundamental problems of finding the true position of the solar system in the stellar universe and determining the relative positions and motions of those stars that, within the range of telescopic vision, compose that universe.

To this latter phase of our science I ask your attention for a few minutes. These problems still lie at the foundation of the "old" astronomy and cannot be relegated to the limbo of useless rubbish or to the museum of curious relics, not even to make room for the new-born astro-physics. On this foundation must rest every astronomical superstructure that hopes to stand the tests of time and of observation, and the precision of the future science depends rigorously upon the accuracy with which this groundwork is laid.

This work was begun in the sixteenth century, but, in spite of all the improvements in apparatus and in methods of analysis and research, a really satisfactory result has not yet been reached. There is no more fascinating phase of the evolution of human thought and skill in the adaptation of means to ends than is found in the development of the mathematical and instrumental means for the determination of the positions and motions of the bodies included in the solar system. Accuracy in astronomical methods and results did not exist, even approximately, until after the revival of practical astronomy in Europe about the beginning of the sixteenth century; and, before the end of that period, the crude instruments of the early astronomers reached their highest perfection in the hands of the skilful genius of Uraniborg.

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[1] Address delivered before Section A of the American Association for the Advancement of Science, by Vice-President J. R. Eastman.

The invention of the telescope, the application of the pendulum to clocks, the invention of the micrometer, the combination of the telescope with the divided arc of a circle, the invention of the transit circle by Roemer, with many improvements in minor apparatus, distinctly stamp the seventeenth century as a remarkable period of preparation for the achievements of the next century.

From the standpoint of the modern mechanician the instruments at the Greenwich Observatory in Bradley's time were very imperfect in design and construction, and yet on the observations obtained by his skill and perseverance depends the whole structure of modern fundamental astronomy. The use of the quadrant reached its highest excellence under Bradley's management.

The next advance, the real work with divided circles, began at Greenwich in 1811, under the direction of Pond. Since that epoch, theory and observation have held a nearly even course in the friendly race toward that elusive goal perfection; and the end is not yet. A careful, but independent, determination of the relative right ascensions of the principal stars, supplemented by a rigorous adjustment of such positions with regard to the equinoctial points, and a similar determination of the relative zenith or polar distance of the same bodies, finally referred and adjusted to the equator or the pole, seem in this brief statement to be, at least, simple problems. If, however, we examine the conditions in detail the simplicity may not appear so evident; and this characteristic may prove to be one reason why this important branch of astronomical research is now so generally neglected.

In the first place, it must be understood that such an investigation cannot be completed in a few months. At least *two* and preferably *three* years' work in observing are necessary to secure good results. Skilled observers, and not more than two with the same instrument, are absolutely necessary. Such work cannot be confided to students or beginners in the art of observing, or to observers who have acquired the habit of anticipating the transit of a star. The telescope and the circles, the objective and the micrometer, the clock and the level must be of the best quality, for imperfections in any of these essentials render the best results impossible. A thoroughly good astronomical clock is the rarest instrument in the astronomer's collection. It is not sufficient that a clock should have a uniform daily rate, the rate should be uniform for any number of minor periods during the twenty-four hours. The absolute personal error in observing transits should be determined at least twice a week, and when it is not well established it should be found every day. The level error should be found every two hours, and the greatest care should be exercised in handling this important instrument. The division marks should not be etched on the level tube unless the values of the divisions are frequently examined, for, sooner or later, such tubes become deformed on account of the broken surface, and are then worthless.

In the determination of zenith distances the effect of refraction plays such an important part that no work can rightly claim to be fundamental until the local refraction has been carefully investigated, and special corrections to the standard tables, if necessary, have been deduced for each observing station. The ordinary mode of observing temperature is quite inadequate to the importance of the phenomena. These observations should be made as near as possible in the mass of air through which the objective of the telescope is moved, and also in the opening in the roof and the sides of the observing room where the outside air comes in contact with that in the building. The thermometers should all be mounted, so that they may be whirled in that portion of the air where the temperature is desired, and they should be tested at least once a year to determine the change in the position of the zero of the scale. But a complete list of the things to be done, and of the errors to be avoided, are too voluminous for this occasion, and are not necessary to show the complex character of the problem; the suggestions already made must suffice.

For many years an immense number of observations of the larger or the so-called standard stars have been made at the principal observatories, for different purposes and with varying degrees of accuracy, but it is not certain that the work of the last thirty years, with all the advantages of improved apparatus, has resulted in more exact determinations of even the relative right ascension of such stars. There can be no doubt that the chronographic registration of star transits has given more accurate results for the smaller stars, but I think it is equally true that, in the case of first and second magnitude stars at least, no improvement has been made in accuracy.

With double threads it is possible to observe the zenith distances of such stars with a fair degree of precision, because the operation is one of comparative deliberation, and the centre of the mass of light can be placed midway between the threads with little difficulty. But the attempt to note, with a chronograph key, the instant when a swiftly-moving and irregular mass of light, like α Canis Majoris or α Lyræ, is bisected by a transit-thread, is an operation that rises but little above the level of ordinary guesswork. Transits of first and second magnitude stars cannot be observed with an objective of more than four inches aperture with the desired accuracy, unless the apparent magnitude is reduced, by means of screens, to that of a fourth or fifth magnitude star. It is necessary in this connection to avoid confounding the methods employed in the observations of the bodies of the solar system with those for obtaining fundamental places of the stars. The observations of the Sun, Moon, Mercury, and Venus with a transit circle are, from the unavoidable conditions, necessarily uncertain to a degree even beyond the probable error involved in the observations of the large stars. In spite of these unfavourable conditions, however, the continued observations of these bodies at the principal observatories for many years have produced the most valuable results, even when the work on the standard stars, on which their results depend, has no claim whatever to a fundamental character.

In geographic exploration the first endeavour is to secure approximate positions of salient points from a rapid reconnoissance. This is followed by more careful work, fixing the observing stations with that degree of precision which ensures good results. Finally, the highest qualities of skill and science are combined to exhaust all available means to reach the greatest attainable accuracy. In the exploration of the heavens, the first two of these steps have already been taken, and most of the stars of the larger magnitudes have been so well observed, that the accuracy of their positions is not only far higher than is required by the greatest skill of the navigator, but it is equal to all the demands of ordinary practical work. It is the next step which challenges the skill of the mechanician, the observer, and the computor; and astronomers cannot rest at ease until all known resources have been exhausted in the attempt to reach the best results. It is not a very difficult matter to fix the position of stars within a range, in the individual observations, of three or four seconds of arc; but that degree of accuracy is not sufficient for the more exact problems of astronomy, and it falls far short of what is required in the important discussions of solar and stellar motions.

Bradley's observations furnish the data for Bessel's "Fundamenta Astronomiæ," and many astronomers have since attempted by reductions to obtain improved positions for Bradley's stars. The value of these observations in the development of modern astronomy can hardly be exaggerated. Their importance in the determination of stellar proper motions increases with the lapse of time, and yet the accuracy of the original observations was far inferior to that obtained in ordinary routine work with modern methods and improved instruments.

Fundamental catalogues of stars have notably increased since the "Fundamenta Astronomiæ," but the demand has not yet been satisfied. The catalogues of declinations or north-polar distances are more numerous than those of right ascension, evidently because, for many reasons, independent declinations are more readily determined.

There is probably no collection of the right ascension of the large stars that has attained, or justly deserved, a higher reputation than the Pulkowa Catalogue. The observations on which this catalogue is founded were made by Schweizer, Fuss, Lindshagen, and Wagner, at the Pulkowa observatory between 1842 and 1853. The observations were reduced by the several observers, thoroughly discussed by Wagner, and published in 1869. Only one observer was employed at any period. As these results have received high praise for their accuracy, and for their freedom from systematic errors, it may be of some interest to consider briefly, and in a general way, the character of the data on which the results depend.

The objective of the transit instrument with which these observations were made, had a focal length of 8 feet and 6 inches and a diameter of 5·85 inches. It was so constructed that the ocular and the objective could be interchanged. It was also reversible, and a part of the observations were made with the clamp east and the remainder with the clamp west. This construction permitted the observations to be made under four different sets of conditions, and for that reason the observed right ascensions of each star were arranged, for facility of discussion, in four separate groups.

An examination of the results in each group discloses some interesting facts that are worth considering somewhat in detail. The whole number of stars in the catalogue that are reckoned as standard stars, and are south of 70° north declination, is 365. Of this number 70 per cent. have a range, in the individual results, in at least one of the four groups, of two-tenths, or more, of a second of time. This range is between 0·20 and 0·29 for 142 stars; between 0·30 and 0·39 for 92 stars; between 0·40 and 0·49 for 15 stars; and 0·50 or more for six stars. The mean range for the 255 stars is 0·297. In general, the accordance between the individual results is quite good, but the discordance just mentioned sometimes occurs more than once in the collected observations of the same star, and these doubtful data have been used in deducing the standard places given in the catalogue. It is not necessary to look for minor discrepancies, for enough of appreciable magnitude have been cited already to warrant the conclusion that better observing can and ought to be done with modern instruments, and that the needs of astronomical science to-day demand a more comprehensive, and a more accurate, standard catalogue of right ascensions.

These remarks must not be interpreted as unfavourable criticism of the Pulkowa Catalogue, by far the best work of its period, but they are made simply to call attention to the fact that the present state of stellar astronomy and the direction which the investigations of the immediate future are likely to take, plainly require the most accurate fundamental catalogue of the standard stars that modern instruments and appliances, modern methods and the most skilful observers can produce. All of these conditions are essential, and they must be carefully co-ordinated to obtain the desired results.

It must be plain to every astronomer that the needed fundamental catalogue must be deduced from new observations. The reduction and the discussion of old observations of doubtful quality is a waste of time and energy. Under existing circumstances the greatest weight must be given to the observations. Neither amount of labour nor skill in computation can derive results of the desired accuracy from careless, incomplete, or incorrect observations. An attempt on the part of the computer to apply any system of theoretical weights, either simple or complex, to such observations is almost certain to lead, at least, to self-deception; and the safe as well as reasonable rule in such case would be to use the weight zero.

One example may serve to illustrate the effect of dealing continuously with old observations. In standard star positions the four principal national ephemerides are not only not in accord with each other, but they generally do not exhibit results even from the few best modern observations. The many discrepancies of varying magnitude in these volumes present with marked emphasis the undesirable results arising from the custom of "threshing old straw."

The data on which these several ephemerides are founded are the common property of all astronomers, and no one can claim the exclusive use of any published observations; and yet national pride or national obstinacy, which is sometimes mistaken for the nobler sentiment, or some computer's pet scheme or system of combination, has led to the adoption of a variety of assumptions in the interpretation and treatment of the original data until our standard ephemerides are so complex in their structure that the exact details of their preparation are practically unknown outside their respective computing offices. The accuracy of the star positions is unchecked by any recent fundamental observations, and they lack that trustworthy character that should inhere in a system intended to serve as a basis for even good differential work.

If this character were wholly satisfactory, we should soon see the representatives of astronomy, geodesy, and geology gathering about the zenith telescope, confident of reaching some definite conclusion in regard to the variation of terrestrial latitudes by the systematic use of this simple instrument. But the accurate star positions do not exist, and under the present conditions the most feasible plan for utilizing this instrument is to so arrange the observing stations as to eliminate the effect of errors in the star places.

If it be admitted that sidereal astronomy is worthy of further and more accurate study, that the needs of astronomical research at the present time and in the immediate future demand more exact positions of the standard stars, it may be desirable to consider briefly the status of those agencies to which we must look for the successful prosecution of such an investigation.

It is not an easy task to determine the exact number of active observatories in the world. Some published lists contain the names of all observatories, from the most expensive and fully equipped Government establishments to the temporary shelter that protects a small equatorial telescope, and perhaps a chronometer, which is kept by the owner for the amusement and possibly for the instruction of himself and his friends. A fair enumeration, however, would probably give a list of about 250 observatories sufficiently equipped to do some kinds of astronomical work. Of this number more than 20 per cent. are found in North America. In the equipment of these 250 observatories are to be found about sixty transit circles with objectives ranging from nine to about three inches. The quality of about one-fourth of these instruments is such that good results may be expected from their proper employment. To the latter class of instruments we are limited when we seek for the highest class of work now under consideration. If we take account of the modern subsidiary apparatus, and of the electric methods of recording transit observations and illuminating the different parts of the instrument, it does not seem extravagant to conclude that, if one third of the best transit circles were devoted for the next four years to observations for the formation of a fundamental star catalogue of right ascensions and north-polar distances, the aggregate result would be not only the best positions ever published, but it would be of the greatest value in the discussion of current, as well as future, astronomical problems. Unfortunately, however, we do not find any such number of instruments employed in fundamental work. At the present time there is no general fundamental work in progress in any portion of the world, and within the last thirty years there have been no results of that character to take the place of the Pulkowa determinations. This statement does not refer to observations of one ordinate only, or to those cases where several observers, both trained and untrained, are accustomed to observe in turn with the same instrument and their several results are indiscriminately mingled in such a way that critical discussion is out of the question. Several observers may work together in the determination of declinations with a fair degree of success, because, to a large extent, each observer's work in a period of twelve or twenty-four hours is independent of that of his fellow's; but even this work is better when done by one skilled observer alone. Fundamental right ascensions, however, cannot be determined with the requisite accuracy, and the necessary freedom from systematic errors, if more than one or, at most, two observers work with the same instrument. If only accidental errors of observation, or such as are due to atmospheric disturbances, uncomfortable positions, or the unsteady nerves of the observer, were introduced by increasing the number of observers, then increasing the number of observations would tend to diminish the error of the result. But the personal errors of observers, and their various habits of manipulation, are of the same nature as systematic errors, and cannot be eliminated by increasing the list of observers or the number of observations.

Of the many valuable star catalogues in existence, I know of none in which the right ascensions depend upon the observations of more than one astronomer, where it is possible to know, or to eliminate, either the constant or the variable errors due to the personal equation of the observers.

In the current astronomical work of this country in which we, as members of this section, are especially interested, observations and discussions, planned solely, and properly carried out, for the determination of absolute star places, are quite unknown. The necessary instrumental outfit, with the exception in some cases of a clock of the requisite quality, exists in several observatories, and I have no doubt that trained observers of the highest character can be found to meet all demands.

With the exception of a few Government establishments, and of those built to promote a higher grade of instruction, the observatories throughout the world have been founded generally for some special purpose. Their existence depended upon some endowment or bequest originating in the real or fancied interest which the wealthy benefactor took in some popular branch of the science, and this founder, with a real enthusiasm for the stimulation of research, and a noble generosity that deserved recognition in a broader field, often unwittingly limited the scope of his foundation and restrained the usefulness of his gift. Utility or novelty, separately or in combination, were frequently the groundwork on which were based the successful claims for pecuniary assistance in founding and maintaining astronomical observatories. The working observatories founded fifty years or more ago, with scarcely an exception, were supported entirely in the belief that the results of the observations would be, directly or indirectly, beneficial to navigation and to commerce. At that time this belief rested upon a reasonable basis. This plea for the construction and support of observatories is sometimes heard even at this period in the evolution of science, in spite of the fact that, if every fixed observatory in the world were destroyed to-day, no interest of navigation or commerce would suffer for the next fifty years. The function of astronomy in promoting the development of navigation and in fostering the extension of commerce has been completed.

In the periodical struggle with wealthy patrons to secure the yearly stipend, and with corporations and legislative bodies to obtain the annual appropriations for the support of observatories, may be found perhaps an apparent, if not a sufficient, motive for selecting the class of work that is pursued in most of the American observatories at this time. The apparent conclusion of those who have sought financial support for astronomical observatories seems to have been that such aid could not be secured except for some special work or research, and that the particular branch of investigation selected must be one that promised either immediate and novel results, or such as would enable capital to win, either in material benefits or in popular reputation, some returns for the risks incurred in speculative advances. Persistence in these theories and in the consequent lines of action, has doubtless resulted in the evolution of a certain type of astronomer, and also of a corresponding type of astronomical patron, whether the latter be an individual, a corporation, or the legislative agents of millions of intelligent people. Such a result would be the obvious outcome of the forces in action.

The motives that actuate the early settlers in new countries, that guide them in the struggle with the untamed forces of nature, arise mainly from the material interests of the pioneer. As the subjugation of the land progresses and the comforts and luxuries of life are substituted for the bare necessities of existence, the higher, intellectual side of humanity asserts itself and demands, not only a hearing in the councils, but also its share in the advantages won in the campaign for material prosperity.

The progress in the development of the various stages of civilization has its parallel in the evolution of the science of modern astronomy. For many centuries the timid navigator skirted the familiar shores of his native land, or, occasionally lured by the hope of unusual gains, he rashly tempted fate by adventurous cruises along distant shores that bore no name in the traditions of his forefathers. But, however lofty his ambition, he never allowed the known or unknown peaks and headlands to sink below his horizon. To him the open ocean was a symbol of infinite space that he dared not explore until astronomy furnished the key to its uttermost recesses, and the art of navigation rose to the dignity of a science.

Greenwich Observatory was founded in 1675 to promote the interests of navigation. The royal warrant appointing the first astronomer royal also declares that his duty is "forthwith to apply himself with the most exact care and diligence to the rectifying the tables of the motions of the heavens and the places of the fixed stars, so as to find out the so much desired longitude of places for the perfecting the art of navigation." Right faithfully have the successive astronomers royal carried out the spirit of the royal mandate. For many years the success was far from uniform, nor was the progress always satisfactory, but, through adversity as well as prosperity, the original design of the foundation was always kept in view, and the results have been commensurate with the effort. If the work of all the other observatories of the world were neglected or destroyed, the data in the annual volumes of the Greenwich Observatory would be sufficient, not only to build anew the science of navigation, but to reconstruct the entire planetary and lunar theories. Surely there can be no more flattering commentary on the value of a well-planned system of observatory work closely followed, through two centuries, with true Anglo-Saxon pertinacity.

The history of Greenwich Observatory is in many respects that of nearly all the observatories, of that early epoch, that have survived to the present time, but most of the urgent needs that led to their foundation have ceased to exist, and new problems have arisen to take their place. The immediate material and commercial advantages, sought for in obedience to the demands of the original foundations, have been fully gained, and the scientific results obtained from the same researches remain a permanent benefaction to the whole world.

To this extent the science of astronomy is deprived of some, perhaps the most efficient, of the influences that commended it to public approval and support during the last two centuries; and the science has now reached a period in its development where we may with propriety consider two pertinent questions. First, what has astronomy gained for itself in the effort to present, in its results, commercial advantages or popular reputation to its patrons, in return for financial support?

Second, what shall be its future attitude when seeking aid in the foundation and endowment of new observatories or in the maintenance of those already in existence?

It may be assumed without fear of contradiction that after the revival of astronomical studies in Europe the rapid development of practical and applied astronomy and the consequent establishment of a large number of observatories was due to the stimulus derived from newly-awakened interests of navigation and commerce. Around these centres of scientific activity the astronomers of the world gathered to discuss not only the problems of practical astronomy, but the more abstruse, theoretical questions which lay at the foundation of the higher branches of the science. The work of each observatory not only furnished the means for determining the accuracy of the numerous theories then extant, but it produced original data on which new theories were constructed, to be in their turn subjected to the rigid test of observation. In the extreme interest evolved in such discussions by those who eagerly sought the key to Nature's methods in the simple form of general laws, the minor problems of practical astronomy were soon solved or passed over to clear the way for the more profound questions that involved the motions in the solar system and the structure of the stellar universe. So, indirectly at first, with a zeal superior to all obstacles, and an ambition that looked beyond the simple and practical idea underlying the original foundation, astronomers have steadily but persistently sought for Nature's general laws in the labyrinth of complex phenomena, have devoted years of intense labour to the most refined tests of methods and theories, and finally, have won for their exacting but fascinating study the foremost place among the sciences. Success in all these labours has justified the wisdom of those royal and wealthy patrons who generously gave their support when a favourable issue was by no means certain.

In its practical results astronomy has returned to mankind a thousand-fold the cost of founding and maintaining its observatories, and at the same time it has developed a science whose field of action includes not only the figure, motions, and positions of our own insignificant planet, but it reaches the uttermost limits of the universe.

If the second question be regarded as involving only a simple problem in ethics it could be readily answered by following the homely, but sometimes pertinent, injunction to "speak the truth." But in view of the complexity of interests now existing this question has a wider signification and deserves some consideration. As already stated, utility or commercial advantage can no longer be given as a reason for carrying on astronomical investigations. Novelty, combined with a desire for architectural display and an absurd ambition to secure the largest telescope and the greatest variety of astronomical instruments, has, even at the present time, a place, and sometimes a prominent one, among the reasons assigned for establishing new observatories. In view of these facts, it is surely the duty of astronomers to see to it that, for their own reputation and for the present and the ultimate welfare of their science, the true purpose of astronomical study and research, and the grounds for the existence and the support of observatories should be frankly given and courageously maintained. It is possible that pecuniary profit may sometimes indirectly arise from some branches of astronomical work or investigation; but the only sound and honest reason that can be given for such work is, that it stimulates the highest form of intellectual activity, widens the already broad field of investigation, and increases the sum of human knowledge. Whoever pleads the cause of astronomy on a lower plane discounts the intelligence of himself or of his audience. Why should the astronomer stoop to select a less noble theme, or consider it from a lower point of view? He who leads an intelligent and thoughtful life must feel himself in daily touch with those phenomena that are involved in the most important astronomical problems of the present and the immediate future. The figure and motions of the earth which he treads; the constitution and translation of the sun that invigorates his life and lights his days; the movements and structure of the moon and planets that beautify his nights; the proper motions and distances of the countless stars that nightly set before his eyes the highest types of rigorous law and of boundless space that the mind can grasp; all of these, and more, tend to convince him that the constantly growing demand for broader and more exact knowledge is ample warrant for the time and expense involved in the most profound astronomical investigation. In this direction lies the justification of astronomical research; on this basis the astronomer is sure of the stimulating support of every cultivated mind as long as the questions "why" and "how" are constantly reiterated and still are unanswered. On this ground, and on this alone, rest the valid reasons for the expenditure of corporate, municipal, or national funds for the establishment of expensive observatories and the prosecution of astronomical investigations; and in the closing years of this century the conscientious astronomer can in no way more thoroughly vindicate the highest claims of his science than by holding the standard of work well above the popular fancies of the hour, and by devoting his time and energy to that class of fundamental work that shall not only satisfy the rigorous demands of the present time, but shall make the last decade of the nineteenth century an important epoch in the real progress of astronomy.

GEOLOGY AT THE BRITISH ASSOCIATION.

NEARLY fifty papers were contributed to Section C during the meeting of the British Association, and although no new facts or theories of startling interest were brought forward, the record of the year's geological work was decidedly above the average. Owing to Professor Lapworth's regrettable illness his address could not be delivered until Monday, and the chair at the meetings had usually to be taken by one of the vice-presidents.

Glacial and local papers occupied the first two days, the most remarkable being the pair by Messrs. Peach and Horne on the Radiolarian Chert of Arenig age, once probably a deep-sea ooze, which covers 3000 square miles in the southern uplands, and passes like the Moffat shales into sediment when traced towards the north. When the chert is traced to within half a mile of the Loch Doon granite the quartz has become quite granulitic, the radiolaria being still recognizable in the matrix although there is a faint development of mica; close to the granite the rock is completely recrystallized, and consists entirely of large quartz particles full of liquid cavities and rounded inclusions of biotite. Dr. Hicks claimed as pre-Cambrian some tender gneisses, schists, quartzites, and limestones, of the central Highlands, of which he gave microscopic descriptions, and Prof. Blake argued that the discovery of *Olenellus* of the type of *O. Thompsoni*, in beds above the Torridon sandstone, did not necessarily parallel these beds with those containing *Olenellus* beneath the Paradonides zone of America. Amongst the other papers dealing with Palæozoic rocks may be noted Prof. Blake's discovery of a felsite like that of Llyn Padarn, apparently intrusive into the Llanberis slates, seen in a new section in the Penrhyn quarries; Prof. Sollas's discovery of bodies like radiolaria in the slates of Howth, and the limestone of Culdaff; and Prof. Bonney's comparison of the pebbles of the English Bunter with those in the old red conglomerates in Scotland.

Several important glacial papers were read. Dr. Crosskey reported on the recording of new erratics chiefly in the north of England. Mr. Lomas traced Boulders of the Ailsa Craig, Riebeckite Rock, on Moel Tryfaen, in Anglesey and the Vale of Clwyd, at Liverpool and Birkenhead. Mr. Bell considered that the evidence from the shell-beds of Clava and Chapelhall was less consistent with the theory of submergence than with that of transportation by land ice. Messrs. Peach and Horne adduced evidence to show that in Sutherland and Ross-shire, at the time of greatest glaciation, the ice-shed was to the east of the present watershed, and the lofty mountains of Assynt and Loch Maree were glaciated by ice travelling westward. Mr. Clement Reid gave a list of twenty-eight species of Arctic plants from a series of silted-up tarns at Corstorphine and Hailes, near Edinburgh. Prof. Axel Blyth exhibited and described a beautiful set of plant remains preserved in calcareous tufas from Gudbrandsdal, in central Norway. The investigation of the Elbolton cave will probably be completed this year, and it has so far failed to reveal any trace of occupation by Palæolithic man. Messrs. Peach and Horne have studied one out of a group of caves in the Assynt limestone of Sutherlandshire, and found charcoal with split and calcined bones of reindeer, fox, and grouse in the upper layers, and a finely preserved canine tooth of brown bear at a depth of about five feet from the surface. Mr. Coates gave a description of the cuttings, chiefly in boulder-clay, in the Crieff and Comrie railway. And Mr. Kendall attributed the glacical period to variability in the heat of the sun.

Foremost amongst the palæontological papers stands that of Mr. E. T. Newton, in which was given an account of several remarkable skulls obtained from the Elgin sandstone and probably belonging to two or three species related to the African dicynodonts; together with these occurred the skull of a reptile allied to Pareiasaurus of the Karoo beds, but with no less than thirty horns varying from a quarter of an inch to three inches in length. Mr. M. Laurie described two new species of *Eurypterus*, two of *Stylonurus*, and one of a new genus, *Drepanopterus*, of Eurypterids from the Silurian rocks of the Pentland Hills. The work of the type committee still continues, and lists have been received from several museums and private collectors. Reports were also presented on Cretaceous Polyzoa and Palæozoic Phyllopoda, and a paper by Mr. Bullen Newton recorded the discovery of *Chonetes Pratti* in the carboniferous rocks of Western Australia.

The petrological papers included a note on the Malvern crystalline rocks, by Mr. Irving; one on the felsites, andesites, and diabases of Builth, by Mr. Woods; and a short note on the Limerick Traps, by Mr. Watts. Mr. Ussher endeavoured to prove that there must have been a rigid mass occupying the position of the Devon and Cornwall granites at the time when the stratified rocks were folded, in order to account for the deviations in their strike. Mr. Goodchild argued that the junction of the granite of the Ross of Mull was best explained by the absorption of sedimentary rocks in the granite. Mr. Harker explained the presence of porphyritic quartz in basic igneous rocks by supposing that it had formed in the upper layers of a magma basin, and sunk to its present position by gravity. Mr. Teall gave a sketch of the succession of rocks in an area of gneisses, which accorded with the succession from basic to acid types in plutonic masses; and Mr. Somervail endeavoured to explain the chief rocks in the Lizard area by segregation from a single magma.

Finally must be mentioned Professor Hull's paper on the Physical Geology of Arabia Petrœa; a very interesting paper by Miss Ogilvie, on the landslips in the South Tyrol, in which she showed how much the mapping of that region was complicated by the constant repetition of portions of the strata by landslips; a new classification of the New Red Sandstone of Northern England, by Mr. Goodchild; and papers on the Green sand and Fuller's Earth of Bedfordshire, by Mr. Cameron.

Dr. Johnstone Lavis's report on Vesuvius chronicled the phases of eruption in the past year, and was illustrated by a beautiful series of photographs, chiefly of fumarolles and spiracles in the streams of lava. Mr. De Rance's report on underground water was continued. Mr. Davison's earthquake report dealt chiefly with new forms of seismic apparatus, and the photographic committee recorded that the collection of geological photographs now numbered 700, amongst which half the English counties and Scotland were, however, poorly represented. An excellent exhibition of the photographs was held in a room provided for the purpose, where also the Geological Survey of Scotland showed a fine series of views illustrating the scenery and structures of the ancient gneisses and schists of the Highlands.

MECHANICS AT THE BRITISH ASSOCIATION.

SECTION G had a good meeting at Edinburgh this year, there being a great improvement on last year's gathering at Cardiff. On the members assembling on Thursday morning the fourth inst. in the old University Buildings the first business was naturally the Presidential address. Prof. W. C. Unwin, F.R.S., who this year occupied the chair, is eminently fitted to preside over the Mechanical Science Section. His knowledge of the scientific side of mechanics is well known, and his past experience in the region of practical mechanics puts him thoroughly in touch with the many engineers who frequent the section. His address, which we have already printed, was listened to by a large audience, the theatre being quite full. The vote of thanks to the President for his address was moved by Lord Kelvin and seconded by Mr. Deacon, of Liverpool.

The first paper on the list was a contribution from Mr. James Dredge and Mr. Robert S. McCormick on the American Exhibition, which is to be held next year in Chicago. The paper gave a good general description of the coming show from the engineer's point of view; but the subject is one that offers better scope for the members of Section F. It is manifestly impossible to give anything like a good engineering description within the limits of a short paper, whilst the advantages and disadvantages of exhibiting might well have supplied a theme for discussion in the Economic Section. In fact, the discussion which followed the reading of the paper turned wholly on this branch of the subject. The next three papers were of a sanitary nature. Prof. George Forbes and Mr. G. Watson, of Leeds, both dealt in the disposal of town refuse, the former bringing in the electrical lighting of Edinburgh as a part of his scheme. Mr. Forbes points out that in the electric lighting of towns the demand for power is but for a few hours daily. With no system of accumulators, or power storage, this necessitates a large plant compared to that which would suffice if the demand could be made continuous. The author, therefore, proposes to use Arthur's Seat as an accumulator, by forming a reservoir on its summit, and into this reservoir water would be pumped continuously. The head of water thus obtained would be used for working turbines, which would be of sufficient power for the maximum demand. There would thus be a gain through keeping the steam engines constantly at work, smaller engines could be used, and there would not be the loss incidental to raising steam or keeping the boiler fires banked. The great feature of the scheme, however, is to use the dust-bin refuse of the city as fuel for raising steam. The author would erect destructors, and the waste heat from these would be passed through the boiler flues. Prof. Forbes quoted figures in support of his contention that the scheme is practicable, and he instanced what has been done at Southampton, and elsewhere, in the matter of using domestic refuse for steam-generating purposes. We are not able to criticise the details put forward, but we may venture to say that, if the scheme can be worked out practically, engineers will have put before them an example of the use of waste material which many have not hitherto considered capable of being so successfully applied. The author stated that the refuse of a city, if properly burnt, would generally supply sufficient heat to raise the steam necessary for the electric lighting required. That is a very satisfactory adjustment of supply and demand, and if Prof. Forbes can show municipal engineers how to put it in practice he will have rendered a most important service for which every one should be devoutly grateful. After disposing of the particular scheme for the refuse destruction and electric lighting of Edinburgh, the author gave some interesting particulars of that which has already been done in this country in the matter of burning town refuse.

The next paper was contributed by Mr. G. Watson, of Leeds, and was an excellent treatise on the refuse-destructor question. The various types of apparatus which have already been put in use were illustrated by wall-diagrams, and the chief points in their construction were explained. Mr. Watson is of opinion, and he supported his opinion by results of actual experience, not only that dust-bin refuse can be burned in a properly constructed destructor without nuisance, but that the waste heat can be used for raising steam; or, if required, that dust-bin refuse and sewage sludge, containing 90 per cent. of moisture, may be satisfactorily burnt together, the Horsfall destructor being, apparently, particularly suitable for the purpose. The whole subject is one of great and growing importance. It is to be regretted that both these papers were not printed and distributed previously, so that a thorough criticism of the various points raised might have been made during the discussion.

A paper by Mr. R. F. Grantham, on the absortpion and filteration of sewage was next read. The author gave accounts of many examples that have been carried out in different parts of the world, and of experiments made in this connection. Mr. Grantham is of opinion that the Maplin and Foulness Sands at the mouth of the Thames might be used to advantage for treatment of the sewage of London.

The next paper was of a different character. It was by Mr. G. F. Deacon, and contained a description of the work the author had carried out in shield tunneling in loose ground whilst constructing the Vyrnwy Aqueduct tunnel under the Mersey. The work, as is generally known, was one of remarkable difficulty, and the manner in which the various obstacles to its completion were overcome affords a valuable lesson for engineers.

Mr. D. A. Stevenson next read a paper in which he advocated the construction of a ship canal between the Forth and the Clyde. The scheme included a tunnel high enough to pass the masts of big vessels, and locks sufficiently large to take in ocean-going steamers. The estimated cost is £8,000,000. After a short discussion of this paper the section adjourned.

On the next day, Friday, the 5th inst., the first business was the reading of a paper by Mr. D. Cunningham, in which he described a mechanical system for the distribution of parcels. The device was illustrated by means of a working model, without the aid of which, or drawings of the mechanism, it would be difficult to make the principle understood.

Mr. Alexander Siemens next described two electric locomotives which his firm had recently supplied to the City and South London Railway. These, as it is proper they should, have been more successful in their working than the engines originally placed on the line. The armatures of the motors are wound on the axles, so that no gearing is required. According to diagrams displayed, the efficiency varied between about 90 and 94 per cent. Each locomotive, fully equipped, weighs 13½ tons, and the weight of the train of carriages is about 21 tons, without passengers. The weight, we believe, is considerably greater than in the original locomotives used on the line, and this is undoubtedly an advantage. Mr. J. H. Greathead, Professors Silvanus Thompson, and G. Forbes took part in the discussion; in replying to which the author attributed the success of the motors to large armatures and large field magnets. Prof. Silvanus Thompson stated that Messrs. Mather and Platt, of Manchester, are now building an electric locomotive which is to be more powerful than anything that has gone before.

Hydraulics next occupied the attention of the section, Messrs. F. Purdon and H. E. Walters describing an interesting tide-motor which they have devised and constructed. The machine takes the form of a floating barge or flat, which is moored athwart the tide-way. There are two drums placed some distance apart, and on these drums a chain is made to travel by floats attached to it, which floats project downwards into the water, and are carried along on the forward stroke by the action of the tide, whilst the return stroke is made in the air. As the flat is moored athwart the stream—in order to utilize the greatest possible area of the current—and as the chain travels fore and aft, guides are used to conduct the water in the proper direction to actuate the floats or paddles. The guides also concentrate the stream. These are roughly the fundamental features of the design, further details of which we are unable to give through limits of space. The machine, however, is very interesting, and is perhaps one of the most promising and best worked-out motors of its kind. There appears now to be better prospect for inventions of this nature than heretofore, on account of the facilities offered for transport of power by means of electricity. It is always a tempting problem to try to use some of the vast store of energy running to waste in the tides, although the question is one beset with practical difficulties that have been sufficient hitherto to make tide-motors very scarce.

A paper by Mr. Pearsall, in which he described a new arrangement of hydraulic ram, which he had made, was next read; Prof. Blyth described a new form of windmill on the principle of the Robinson cup anemometer; and Mr. G. R. Redgrove having read a contribution on Levavasseur's flexible metallic tubing, the second day's proceedings were brought to a close.

The next sitting was held on the following Monday, the section not meeting on Saturday. The arrangement was decidedly a pleasant innovation, the Saturday morning's meeting being by no means popular. Whether there be few or many papers, it seems impossible to get through a sitting in a short time, as there are always one or two speakers, at any rate, who will spin the discussions out, so that those who are obliged to stay to the end have no time to get lunch before starting on the excursions. Section G made a trip to Glasgow on the Saturday, and were rewarded by perhaps the finest exhibition of marine machinery ever collected in a single installation. This comprised the propelling engines of one of the pair of enormous vessels the Fairfield Company are building for the Cunard line. The engines were erected in the shop, and one was enabled to get a fair prospective of their grand proportions, such as will be impossible when they are confined to their natural position on shipboard.

On the section again assembling on the Monday following the first business was the reading of the report of the committee appointed to consider "The Development of Graphic Methods in Mechanical Science." This report had been prepared by Prof. Hele-Shaw, of Liverpool, who must have spent a vast amount of pains in compiling the very bulky document, which was read in abstract. The bibliography should be especially valuable. This is the second report that has been presented by the committee, and, we believe, the subject is to be further investigated. The use of graphic methods is far less common with engineers than it might be with advantage, and the matter is one which the Mechanical Section of the British Association is especially fitted to deal.

Mr. Preece next read two papers, in the first of which he took the municipal authorities to task for causing stack pipes to be disconnected from the drains, and thus depriving these natural lightning-conductors of their lead to earth. If Mr. Preece's prognostications are fulfilled there will be a great increase in casualties from lightning when the new legislation comes widely into effect, unless some other means be taken to make connection between stack pipes and earth. Mr. Preece did not read his second paper, but contented himself with saying a few words to signify its scope. Its title was "The use of secondary batteries in telegraphy." For the past seven years secondary batteries have been used at the Post Office to supply current to two large groups of circuits, one group consisting of 110 single needles, and the other of 100 Morse inkers and sounders.

Mr. Gisbert Kapp next read a practical and interesting paper on "Power Transmission by Alternating Current," describing an installation which has been carried out at Cassel. In that town the water supply is a municipal undertaking, the source being at a distanee of four miles or so from the town. In the summer a large quantity of water is used, and for this reason a certain amount of pumping has to be done. The pumps are worked by turbines. In the winter the existing natural gravitation supply is sufficient, and the turbine pumps are, therefore, not required. It is, of course, in winter that the chief demand for light occurs and then the turbines, in place of being idle, are used for driving dynamos. Mr. Kapp explained by means of diagrams the manner in which a storage system is carried out so that the turbines may be kept constantly at work. The power is transmitted by a single phase alternating current from the generating station to two sub-stations at Cassel. At one of the sub-stations there is a battery which is charged during the hours of light load, to be in turn drawn upon during the time of heavy load. Each of the two sub-stations contains a transformer so that the distribution is by continuous current, whilst between the generating station and the sub-stations the current is alternating, the pressure being 2000 volts. The installation was the work of Mr. Oskar von Millar, Mr. Kapp designing the alternators. The author gave a good many details of the arrangement of which the above is an outline. In the discussion which followed an interesting point was raised as to the effect of putting the alternators out of step. The author said that in the present instance he had no hesitation in putting the load on suddenly and no effect followed, but if the load were suddenly taken off, the machine would start howling in a frightful manner until it again got in synchrony. This was alarming at first, but not otherwise hurtful.

Mr. E. H. Woods next read a paper in which he gave particulars of a new design of electric locomotive. The driving wheels are placed horizontally, the necessary grip being, we understood, obtained by springs, which press the pairs of wheels against a central rail. There is an ingenious device for points and crossings which was illustrated by a model. The motor is to be kept running continuously, the grip of the wheels being released when the train is stopped, the power then be absorbed by frictional brakes. The relative value of this device naturally depends on the length of the stoppage. Mr. Kapp and Prof. Forbes both spoke on the question of continuous running motors, neither appearing to look with favour on the device.

Monday is generally devoted wholly to electrical engineering, but on this occasion the papers on the subject were not sufficiently numerous to fill up the sitting. The rest of the day was, therefore, filled up with papers of a miscellaneous nature. The first of these was a contribution by Lieut. W. B. Basset, R.N., who described a very ingenious coin-counting machine which has been recently placed in the Royal Mint. It would be impossible to describe this apparatus without the aid of drawings; but it may be stated that 3,000 coins can be counted in a minute, or one ton in three-quarters of an hour. The coins are made to move along a channel of such a size that only one can pass at a time. They are forced along by means of two driving wheels, actuated by an electric motor. At the lower end of the channel is a wheel with notches in its rim, the notches being of a shape that the coins just fit into them. The wheel is made to turn by the coins as they are forced forward, the action being comparable to that of a rack and pinion, the rack being formed by the procession of coins pushed forward by the driving wheels. The counting wheel must necessarily pass a coin for each notch or tooth it advances, and as a given number of teeth always go to a revolution, an accurate record is obtained. The machine in the Mint is arranged to count pence, half-pence, piastres, half-piastres, and Hong Kong cents. It counts on an average over two million coins a month without error.

Mr. Killingworth Hedges next read a paper on "Anti-Friction Material for Bearings used without Lubrication." This referred chiefly to a bearing composed of finely-powdered carbon mixed with steatite, which the author had found valuable. He referred to the advantages of non-lubricated bearings, such as saving in labour, cost of oil, and cleanliness. In the discussion which followed, Professor Unwin well summed up the question by saying that though there might be a higher co-efficient of friction with a non-lubricated bearing, manufacturers could generally well afford a small additional expenditure of power in order to be free from the defects of oiled bearings.

A paper by Mr. B. H. Thwaite on high-pressure boilers, which does not call for notice here, was the last read on this day.

The last day on which Section G sat was Tuesday, the 9th inst., when the proceedings were opened by a paper by Mr. D. A. Stevenson, entitled "Petroleum Engines for Fog Signalling," being read. The paper, which was read by Mr. C. A. Stevenson in his brother's absence, stated that the maximum number of hours of duration of fog in Scotland was 395 per annum. For sounding the siren various motors are available, which may be actuated by the waves or tides, manual labour, clockwork, steam, hot air, gas, or oil. The author states that the oil engine is the best for the purpose. He states, however, that all fog signals which appeal to the ear must be of an unreliable nature, and he would prefer some method, such as had been proposed by Mr. C. A. Stevenson, in which an electric conductor is laid down off a coast, so as to act on an instrument attached to each vessel. It would have added to the value of the paper had sufficient detail of this device been given to afford the meeting an idea of its general principle. As the description stands we quite fail to see how a useful result could be brought about. An interesting discussion followed the reading of this paper, in which the chief feature was the speech of Mr. A. R. Sennett, who pointed out that water is a better medium than air for conveying sound, and reminded the meeting that sound was very liable to be deflected by "acoustic clouds." Tyndall found that the presence of such clouds reduced by one-third the distance at which a given sound could be otherwise heard. Mr. David Cunningham, the harbour engineer at Dundee, gave a remarkable example of the influence of acoustic clouds. He had gone out in a steam yacht when the siren was in operation. At a distance from it of half a mile the sound was not to be heard, but when they had steamed four miles the siren was again audible. It had been sounding the whole time. To return to Mr. Sennett's remarks, that speaker said he proposed taking advantage of the sound-carrying power of water in the following way. He would have the siren, which indicated a danger, submerged in place of being in the air. It would be arranged to give off a certain note. In each ship there would be a chamber to which the sea would have access, and in this would be a diaphragm which would be tuned to the same note as that emitted by the siren. By the well-known law the diaphragm would not resound unless the note to which it might be attuned were in harmony with that given off by the siren, and therefore false alarms would not be given by the sounds produced by paddle wheels or in other ways. An officer would be placed in a padded cabin, so as to isolate him from the noises of the ship, and by means of an ordinary speaking-tube he would be able to hear the vibrations of the diaphragm, which, as stated, would only take place when they synchronised with the sound-waves produced by the siren. Mr. Sennett's proposal is ingenious, and may contain the germ of a principle of great value. We understood him to say that he had made some experiments in this direction, and that these had been encouraging. It is obvious, however, that investigations of this nature must be somewhat costly, and can lead to but little prospect of pecuniary reward. We would suggest that the matter is one that might well be taken up by the Board of Trade or the Trinity House. Perhaps some of those big shipowners who do their own insurance might be induced to give assistance in this direction. It is quite possible, and indeed probable, that we have been entirely on the wrong tack in sending sound-signals through the air. The experience of Prof. Hughes, quoted by Mr. Sennett, when he found the sound of two stones being knocked together under water could be heard for a distance of half a mile, and heard so distinctly that the Professor did not wish to repeat the experiment, bears on this point. An ordinary bell has been struck under water, and the sound conveyed a distance of nine miles.

Mr. C. A. Stevenson next read a paper of his own "On the Progress of the Dioptric Lens as used in Lighthouse Illumination." This paper was largely historical, going back to the early days of the century, when Alan Stevenson introduced the Fresnel apparatus in Great Britain, and bringing the record up to the year 1886, when the author proposed the spherical lens, an example of which was introduced in one of the Fair Isle lighthouses. This introduction of the spherical refractor has made practicable the construction of more powerful apparatus, with less total space occupied. It has also rendered practicable a quadrilateral arrangement with hyper-radiant lenses. This arrangement has been installed at Fair Isle, the lenses being cut so as to give two flashes from each side of the quadrilateral. An experimental example for Ireland is 2 m. focal distance, and the spherical refractor is 7′ 6″ in diameter, and will give one flash from each side of the quadrilateral.

Mr. A. R. Sennett next read a paper which was both interesting and of practical importance. Its theme was the much ill-treated smoke-prevention question, and we may at once say it was refreshing to find this important but ever-abused problem approached in an intelligent manner. Mr. Sennett has evolved a very simple device which, it might perhaps be rash to say, has exorcised the smoke fiend in regard to boiler furnaces; but if we are to accept his statements—and we see no reason why we should not—there is no longer excuse for steam users allowing smoke to emerge from boiler chimneys. We all know it is not difficult to prevent smoke if fuel economy be left out of the question, but Mr. Sennett tells us he not only prevents smoke, but saves coal. The latter part of the claim is vouched for by Professor Alexander Kennedy, who is perhaps our best authority on this subject; and, with regard to the smoke prevention, Section G was able to judge for itself, as the author had a fair-sized return-tube boiler at work in a yard close to the meeting-room. The paper was of considerable length, but was listened to with interest throughout. By means of wall diagrams, devices of various classes, previously introduced, were illustrated and described. These played much the same part as the awful example at a teetotal lecture, only serving to emphasize the virtues of the author's own invention. Some of them, it must be confessed, were sufficiently absurd; one especially, in which the products of combustion were cleansed from soot by a sand filter, afforded the meeting a good deal of amusement. We imagine the impression of the average engineer to be that the drier and hotter the air fed to a furnace the quicker and more perfect would be the combustion. This Mr. Sennett shows to be not exactly the fact, or, at any rate, that the presence of steam with the air promotes combustion. He says that hydrogen, steam, or aqueous vapour, in the furnace is necessary. He combats the view, "too readily assumed," that the presence of an excess of oxygen contained in dry air will of necessity effect complete combustion. The advantage of supplying air above the grate bars, as well as below, is, of course, well understood, and it is with the volume of air introduced above that the author chiefly deals. His device consists chiefly of an air injector, the steam for inducing the air-current being super-heated in a coil placed in the chimney. The apparatus is termed a transformer, because it transforms the kinetic energy of a small current of steam at high pressure into that of a large current of air at low pressure: a description which conveys the whole scheme of the invention, although the working out of the details requires some attention. With the transformer Mr. Sennett has carried out some experiments. He worked it firstly by steam, and secondly by compressed air, and he found that the volume of air required for combustion was very much less in the former case than in the latter. In explanation, or rather in illustration, of this fact the author quotes several interesting facts. Mr. H. Brereton Baker investigated the phenomena which accompany the burning of carbon and phosphorus in oxygen. Finely powdered charcoal was carefully dried and sealed up in a hard glass tube containing oxygen saturated with water. The tubes were placed in a flame, and the carbon burnt with bright scintillating flashes. When the oxygen was dry no combustion took place in the tube, though the latter was heated to bright red; a result which came clearly as a surprise to many of the members of non-chemical Section G. Mr. Baker has said that the results obtained clearly show that the burning of carbon is much retarded by drying the oxygen. With regard to the presence of moisture and the behaviour of carbonic oxide gas in oxygen the effect is even more remarkable. The author quotes Prof. H. B. Dixon, who says: "That if the mixture of the two gases be very carefully dried it is no longer explosive, and a platinum wire may be heated to redness in it without causing explosion; oxidation of the carbon monoxide to dioxide then taking place gradually, and only in the immediate neighbourhood (at the surface) of the glowing wire. A burning jet of carbonic oxide may even be extinguished by plunging it into a jar containing dried oxygen." We will quote one more interesting fact in connection with this subject. Sir Lowthian Bell has noticed that the gases at the throat of blast furnaces, which are of a temperature of about 250 to 300 Cent., are not inflammable in atmospheric air. Any small quantity which escapes does so without undergoing combustion. But the moment a tuyere commences to leak the gas takes fire; just as a small quantity of hydrogen in the eudiometric researches produced explosion in a mixture not previously influenced by the electric spark. The author does not attempt to decide whether the acceleration or retardation of the union of oxygen with the evolved hydro-carbon gases is due to the presence of aqueous vapour or of the hydrogen. Section G may fairly look to Sections A or B for enlightenment upon that point.

We have given so much space to what we think the most interesting part of Mr. Sennett's paper that we may, perhaps, be doing him the injustice of suggesting that other points do not receive attention. This, however, is not the case, for he does not lose sight of the leading canons of furnace practice, such as proper admixture of the gases, adequate space for combustion, keeping the gases from contact with the heating surface (from this point of view the cooling surface) of the boiler, and other matters, of a similar nature. The result of the whole arrangement is that smoke is undoubtedly prevented from issuing from the funnel. In the boiler referred to a very dirty coal was burned, the result being a particularly pungent smoke, which was sometimes carried down among the spectators by an eddying wind. When the transformer was put in operation this smoke entirely disappeared. Upon the apparatus being put out of action the sable cloud was again to be seen rolling forth from the chimney-top. These operations were repeated several times, the fire being constantly supplied with green fuel, so as to keep it in its smokiest condition.

Following Mr. Sennett's paper a contribution on the same subject was read by Colonel E. Dulier. The author of this paper deals with the domestic fire, to which, of course, the greater part of the smoke of civilization is to be attributed, but he does not aim at the prevention of smoke, but simply to its arrestation before its gets into the air. In order to effect this object he proposes to wash the chimney gases with a spray, and thus precipitate all soot. He also claims to arrest the greater part of the sulphurous acid, which is of even greater importance. Every dweller in towns and cities will wish Colonel Dulier well in his enterprise, but there are some very big difficulties in his way. The biggest perhaps is that before the plan can become general legislation must be brought to bear. Unhappily dwellers in towns and cities are so little disinterested that the average householder would prefer to see his next-door neighbour erect a costly apparatus (the first cost for a seventeen-chimney house is said to be about £50) rather than go to the expense himself. The large quantity of water required for a general smoke-washing would be a serious problem, not only of cost but of supply at any price, although it is quite possible this difficulty could be, as it should be, met. The cleaning out of the apparatus would be also a serious matter, for the tarry deposit due to smoke-washing is of a particularly tenaceous nature.

The sewage problem next occupied the attention of the meeting, Mr. Crawford Barlow reading a paper on "The London Sewage Question." Mr. J. Cooper also read a paper on "The Sanitation of Edinburgh." The last paper read at this meeting in this section was contributed by Mr. H. C. Carver. It related to fire extinction on board ship. The author has devised an apparatus by means of which he can turn the effluent gases from the boiler furnaces into the hold of a ship where fire is raging; the gases having been previously washed and cooled. The apparatus has been tried practically, and has been found to answer remarkably well. The ordinary practice is to turn boiler steam into a ship's hold; but the spent gases from the furnace are naturally more effective, as steam condenses, and air is thus drawn in. Nevertheless, steam is better than nothing.

After the usual votes of thanks the business of the section was brought to a close.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

After the President's address, on Thursday, August 4, Mr. E. W. Brabrook read a paper on the Organization of Local Anthropological Research. The writer, as the representative of a joint committee of delegates from the Society of Antiquaries, the Folklore Society, and the Anthropological Institute, communicated a plan for an ethnographical survey of the United Kingdom, by which observations should be made simultaneously in selected localities on the ancient remains, the local customs, and the physical characters of the people. The matter is one that will not brook undue delay, as the evidence is fast slipping out of our grasp.

The Rev. Frederick Smith read a paper on the Discovery of the Common Occurrence of Palæolithic Weapons in Scotland. The author has made patient and long-continued search in modern and ancient gravel beds of existing rivers, in "Kame" deposits, and finally in certain phases of boulder clay; and he finds abundant evidence in the shape of glaciated, broken, and crushed specimens of the weapons of palæolithic man. He has collected at least 350 specimens, which he believes to be definite evidence of the long-continued sojourn of palæolithic man north of the Border.

A paper on Cyclopean Architecture in the South Pacific Islands was read; also the Reports of the Anthropometric Laboratory Committee, and of the Anthropological Notes and Queries Committee.

In the afternoon the following papers were read:—Dr. L. Manouvrier, On a Fronto-Limbic Formation of the Human Cerebrum; Prof. G. Hartwell Jones, The Indo-Europeans' Conception of a Future Life and its Bearing upon their Religions.

On Friday, Mr. J. Graham Kerr exhibited a collection of weapons, articles of clothing, and a fire drill, used by the Toba Indians of the "Gran Chaco." He accompanied the exhibition with a few explanatory remarks. The specimens had been obtained from a tribe of the Tobas on the banks of the Rio Pilcomayo. Amongst weapons the chief were bows and arrows, the former being noteworthy from their reinforcement by a back string. The arrows were of cane, with long wooden points made of cascarandá. An arrow with an iron head was also shown, the head being formed of fencing wire beaten out.

Mr. J. Montgomerie Bell exhibited a collection of flints from the North Downs of Kent, which he called "pre-palæolithic." The peculiarities of these flints is that they are not shaped into particular forms by the will and skill of the workman, as palæolithic flints are, but they are simply stones taken from the ground and used almost in the state in which they are picked up; only the edges are altered; they are chipped flints rather than shaped flints; used tools, not made tools. Mr. Bell explained the reasons which had convinced him of their authenticity; namely, that the chipping is regular and purpose-like, such as Nature is not likely to have hit upon; it is sometimes within a hollow curve, where natural agencies could not act; the edges of many unbulbed flints have far more regular marks of wear, which is the true indication of use by man, than many bulbed flakes possess, whose edges have undoubtedly been used; and lastly, there is a sequence in the types which leads into the types of the river-valley period.

Mr. J. Theodore Bent read a paper on the Present Inhabitants of Mashonaland and their Origin. The inhabitants of this country are an oppressed and impoverished race of Kaffirs, who dwell amongst the rocks and crannies of the mountains. Their recognized name—Makalanga—means "the children of the sun," and there were traces of a higher civilization amongst them. Their origin is obscure, but references to them by early Arabian writers prove beyond doubt that a similar people inhabited the country one thousand years ago. Each tribe has its totem. Their religion has a monotheistic tendency, but they sacrifice to ancestors, and sacrifice goats to ward off calamities. Their manners are courteous and refined, and their skill in music is considerable.

Prof. A. C. Haddon contributed a paper on the Value of Art in Ethnology. In order to study such an intricate subject as Decorative Art from the point of view of the Biologist it is necessary first to confine one's attention to savage art where the problems are presented in a simpler form. In taking a definite area into consideration, such as British New Guinea, one finds that there are several distinct and well-defined artistic provinces. The Torres Strait district was characterized by the prevalence of straight and angled lines to the exclusion of curved lines and the representation of animal forms, the latter being associated with totemism. In the Gulf District the human face and form is the basis of almost all their art. In the Port Moresby District decoration is in the form of panels and mainly straight and angled lines; whereas in the South Cape and Archipelago District there is a wonderful richness of design in which curved lines are abundant.

It is well known that in this latter district there has been a great mixture of race. It would appear that homogeneous peoples have a uniform style in their art, but that race mixture tends to varied artistic treatment.

Dr. J. S. Phené read a paper on the Similarity of Certain Ancient Necropoleis in the Pyrenees and in North Britain. At Luchon, a spot where the traditions of the Pyrenees were most concentrated, remarkable customs had till recently been practised. The locality abounded with interments of a peculiar kind, more or less surrounding a central mound, serpentine in form, the head of which had been cut away and a small church erected in the cavity. The walls of this antique little church are covered with votive tablets of early Christian and pagan Roman times. Almost all the features shown had been discovered by the author in Somersetshire, Bedfordshire, Argyleshire, and Peebleshire.

The following papers were read:—A Contribution to the Ethnography of Jersey, by Dr. Andrew Dunlop. Notes on the Past and Present Condition of the Natives of the Friendly Islands, or Tonga, by Mr. R. B. Leefe. Damma Island and its Natives, by Dr. F. Bassett Smith. The Reports of the Mashonaland Committee, and of the Canadian Committee were also read.

In the afternoon a discussion on Anthropometric Identification was opened by Dr. Manouvrier, who described the system of measurements introduced by M. A. Bertillon into the French Criminal Department, and showed the manner in which they were made. He said that by its means the identification of criminals was made absolutely certain. Dr. Benedikt of Vienna also bore testimony to the efficiency of M. Bertillon's system and strongly advocated its introduction into Great Britain. Dr. Garson referred to Mr. Galton's method of identification by means of finger marks.

As a result of this discussion the Council have been requested to draw the attention of her Majesty's Government to the subject.

A discussion on the subject of Criminal Anthropology was opened on Saturday by Dr. T. S. Clouston, who reviewed the work done in this and other countries, and pointed out the failure of the workers to agree on any anatomical, physiological, or psychological data for establishing a criminal type.

If inquiry established physical, hereditary, and psychological bases of criminality, the State would have to treat the criminal from a point of view entirely different from the punitive method. The essential likeness of the epileptic and the criminal brain is one of the most striking of Dr. Benedikt's observations. What were to the doctor symptoms of disease were to the policeman and the magistrate proofs of criminality. In the rich family the physician looked after the case, in the poor family the policeman and the gaoler. Yet both cases were equally phases of brain development due to hereditary weakness.

Dr. Benedikt emphasized the importance of studying criminals of different types. They must study the classes from which the criminals came, and must not confuse the poor and miserable with the criminal classes.

On Monday Sir William Turner exhibited the coiffure of a Kanaka labourer who had been employed on a sugar plantation in Queensland. The mode of dressing the hair in locks, each of which was tied round with a narrow ribbon formed of vegetable fibre, was described. 834 such locks were present in the coiffure, and it was estimated that about 120 hairs were in each lock, making in all about 100,000 hairs in the coiffure.

Prof. Struthers read a paper on the Articular Processes of the Vertebræ in the Gorilla compared with those in Man; and on Costo-vertebral variation in the Gorilla.

Mr. J. P. Mansel Weale made a communication on the probable derivation of characteristic sounds in certain languages from the noises made by animals.

Dr. Louis Robinson read a paper on the prehensile power of infants. Long-continued experiments had proved that the muscles of the hands and arms of a newly-born infant are far stronger in proportion to weight than those of most healthy adults. In many cases a newly-born child would hang and support its weight with ease for a minute, and some for thirty seconds longer. Several infants less than a week old hung for over a minute and a half, a few others a fortnight old for nearly two minutes, and one child of about three weeks old for two minutes thirty-five seconds. If the child were in a good temper to begin with it would hang quite placidly until its fingers began to slip, when it at once evinced distress, and screamed lustily as if from a fear of the consequences of falling. An examination of the foot of an infant showed that it was much more hand-like than that of the adult. The heel was much narrower than in after life, and the fore part of the sole, instead of presenting a rounded smooth surface, was flat or even concave, with creases like those of the palm of the hand. The author was not aware that any explanation could be given of these lines, so characteristic of a prehensile organ, on the foot of the human infant, other than that they were vestiges of an arboreal state of existence. He believed that it was due to the habit of the young clinging to the body of a parent who would require to use all her limbs for climbing.

Dr. Hepburn read a paper on the Integumentary Grooves on the Palm of the Hand and Sole of the Foot of Man and the Anthropoid Apes.

In a communication on the Contemporaneity of the Maori and the Moa, Mr. H. O. Forbes gave an account of the exploration of a cave in the neighbourhood of Christchurch, which had been closed by the landslip of a great part of the mountain at whose base it lay. From the remains of the last feast partaken of by the dwellers in this cave, it was clear that Moa eggs had been eaten by them, and therefore that the bird that laid those eggs was contemporaneous with the eaters. The ornamentation of the implements, &c., found in the cave proved that the cave-dwellers were true Maoris.

In the afternoon Dr. Garson opened a discussion on Human Osteometry, in the course of which Sir William Turner explained and demonstrated his method of taking the capacity of crania by the use of shot poured into the cavity of the skull through a funnel, the spout of which was 2 cent. long and 2 cent. in diameter. It was claimed for this method that it gave the actual capacity and did not over measure it as is the case with the plan adopted by Broca.

On Tuesday Dr. J. G. Garson exhibited some composite photographs of United States' soldiers.

Dr. Francis Warner contributed some Observations as to the Physical Deviations from the Normal as seen among 50,000 Children. The most important defects were found to be those of the cranium as indicated by the proportion among them delicate, dull, and with nerve disorder or weakness; many of these cases are doubtless due to rickets. Small heads were especially common among girls, the only defect to which they seem specially liable. The greatest amount of defectiveness did not occur in the poorest districts; for in the wealthier parts of London 12½ per cent. showed deficiency, while in the poorer districts only 7 per cent. showed defects.

The following papers were read by Prof. A. Macalister:—On Skulls from Mobanga, Upper Congo; On some Facial Characters of the Ancient Egyptians. It was remarkable how little variety was to be found in the heads of these ancients. The hairs of the eyebrows were small, and that on the head was not woolly but wavy. The nose was well formed, usually prominent, rather high-bridged and narrow. The nostrils were narrow, and very rarely was there much of a moustache. The chin was narrow and tapered. There were no traces of holes in the lobes of the ears. Prof. Macalister also read a paper On the Brain of an Australian.

Dr. Garson read a communication On some very Ancient Skeletons from Medum, Egypt. These skeletons were somewhere about 6000 years old, and their most interesting feature was that in the upper and lower limbs they had markedly negro characters. In the pelvis they had intermediate characters between the Egyptian and the Negro, while in the head they had well-marked Egyptian characters.

The following papers were also read:—C. Phillips, On a Skull from Port Talbot, Glamorganshire; Dr. R. Munro, On Trepanning the Human Skull in Prehistoric Times; E. H. Man, On the Use of Narcotics by the Nicobar Islanders, and certain Deformations connected therewith.

The reports of The Indian Committee, of The Prehistoric Remains of Glamorganshire Committee, of The Elbolton Cave Committee, and of The Prehistoric Inhabitants Committee were submitted.

In the afternoon Mr. G. W. Bloxam exhibited The Philograph—a Simple Apparatus for the Preparation of Lecture Diagrams, &c., and Dr. Louis Robinson showed a series of photographs illustrating his paper on the prehensile power of infants.

CONFERENCE OF DELEGATES OF CORRESPONDING SOCIETIES.

FIRST CONFERENCE, AUGUST 4, 1892.

THE Corresponding Societies' Committee was represented by Prof. R. Meldola (chairman), Sir Douglas Galton, Mr. G. J. Symons, Mr. W. Whitaker, Mr. E. B. Poulton, Mr. Cuthbert Peek, Dr. Garson, and Mr. T. V. Holmes (secretary).

The Chairman, after welcoming the delegates to the seventh conference which had been held under the new rules of the Association, said during the seven years of their existence they had, he ventured to think, done some good work for the Association and for themselves. They occupied now in relation to the Association very much the same position as one of its sectional committees, and for that they were very largely indebted to Sir Douglas Galton, who had very keenly watched their proceedings, and had taken a great interest in them. The report of the committee was then submitted, and the different subjects which had engaged attention during the year were dealt with under the heading of the Association Sections to which they belonged.

In Section A the Chairman introduced the subject of Temperature Variations in Lakes, Rivers, and Estuaries, but no delegate specially interested therein being present, the Conference proceeded to that of Meteorological Photography. Mr. Clayden and Mr. Symons spoke of the desirability of photographs illustrating the damage done by whirlwinds and floods, and Mr. W. Watts (Rochdale) said that the Society he represented was taking up the subject. Mr. Symons mentioned the Helm Wind of Crossfell and the peculiar cloud accompanying it, photographs of which would be useful. Mr. Watts stated that a difficulty in photographing the effects of floods arose from the state of the weather during their occurrence, and Mr. Cushing (Croydon) exhibited photographs of a recent thunderstorm. The Chairman then remarked that Mr. Kenward (Birmingham), who was unable to be present, had sent a letter stating that for some years in Birmingham meteorological observations had been made in the building called "The Monument." Mr. Symons and Dr. Stacey Wilson discussed the mode of operations pursued at Birmingham.

After some remarks by Prof. Merivale, the Chairman, and Mr. Symons, the Conference passed on to Section B.

In Section B the Chairman introduced the subject of the conditions of the atmosphere in manufacturing towns, and Mr. Mark Stirrup (Manchester) and Mr. Watts (Rochdale) said that observations and experiments were being made thereon in their respective districts.

Mr. De Rance (Section C) stated that the 18th Report of the Committee on Underground Waters had been read that morning; that the Committee thought it should be reappointed, and that a volume containing abstracts of the previous Reports should be published. The Committee on Coast Erosion hoped to conclude its labours next year. The Committee on Erratic Blocks continued to do good work. The Local Societies could do much to assist this Committee by noting the position of boulders, and by preserving them from destruction. Prof. Lebour (Section C) postponed his remarks on Earth Tremors.

Mr. Watts (Rochdale) spoke upon the denudation of high-lying drainage areas, and some observations he had made on the amount of material brought down by flood waters, and the degree of protection given by heather, grass, and peat. Dr. H. R. Mill said that something had recently been done in Germany to ascertain the amount of sediment in river water. He thought it very desirable that a series of observations should be made to determine the relative values of woodlands and heather in protecting land, and was inclined to suggest the formation of a Committee for that purpose. Mr. Watts said he would be glad to give information as to the methods followed in Rochdale.

Geological Photography.—Mr. Arthur S. Reid (East Kent) said that Mr. Jeffs had asked him to speak on the work of this Committee. The number of photographs amounted to about 700. He exhibited a specimen volume of photographs, and explained the way in which they were mounted and bound. He thought it important that some uniform plan of photographing geological subjects should be adopted, and that the plates used should be orthochromatic or isochromatic. Mr. W. Gray then spoke of the photographic work done by the Belfast Naturalists' Field Club, and Dr. Stacey Wilson of that of the Birmingham Philosophical Society; Mr. J. Barclay Murdoch mentioned the course proposed by the Geological Society of Glasgow, and the Chairman recommended the use of orthochromatic plates.

The Chairman invited remarks on the destruction of native plants and of wild birds' eggs. The Rev. E. P. Knubley (Yorks. Nat. Union) alluded to the Report presented to Section D on the disappearance of native plants and its causes. Mr. Watts said that two or three members of the Rochdale Society proposed to work at this subject. Mr. Mark Stirrup had a short paper by Mr. Leo. H. Grindon on the disappearance of wild plants in the neighbourhood of Manchester. The Chairman thought it might be read at the second conference. Mr. Cuthbert Peek remarked on the great difficulty of obtaining a conviction in cases in which ferns and other wild plants had been taken from private grounds.

Destruction of Wild Birds' Eggs.—The Rev. E. P. Knubley said terrible damage had been done by the destruction of birds' eggs. It was a serious matter, but it was very difficult to know what to do in regard to it. For instance, take the case of the great skua, which nested in the Shetland Islands; in 1890 it is said that not a single chick was reared on the whole of the Foula colony. Every egg was taken, and in 1891 all the eggs of the first laying were taken by the inhabitants and sold to dealers. Other rare birds which nested in the Shetland Islands were also persecuted. He had it on good authority that last year not more than two or three nests of the red-throated diver got off their young; and the black-throated divers were not more fortunate. One shilling apiece was given by dealers for the eggs of the red-throated diver and 10*s.* a brace for those of the black-throated diver. The whimbrels, which also nested on the same islands, had been reduced to about twenty pairs, and were likely to disappear. The red-necked phalarope was very much in the same circumstances. The dealers gave a commission to a local man, who was to get about 3*d.* a dozen for every egg collected of all sorts and kinds. The local men in turn got the herd boys to sweep the country of every egg they could lay hands on, big and little, and for these they got about 1*d.* a dozen. That was one way in which parts of Scotland had been regularly swept, and that in spite of such protection as the owners could afford. They had men who followed about strangers all day, but the natives took the eggs at night. Then, again, one might mention that one heard that in Edinburgh there was a gentleman who made it his boast that he had over 100 eggs of the golden eagle. What was to be done with a case of that kind? In some parts of England things were not any better. The nesting stations of the lesser tern which existed on the Fifeshire coast, the Lincolnshire coast, and at Spurn, in Yorkshire, would shortly disappear altogether. The oyster catcher and the Arctic tern had practically ceased to nest on the Lincolnshire and Yorkshire coasts, and the ringed plover was much scarcer than formerly. The redshanks and greenshanks had in many parts also been persecuted to the death. The nests of the bearded reedling, whose breeding station in the British Islands was the Norfolk Broads, had been to his own knowledge systematically poached for sale for a number of years. The only hope seemed to him to be in the creation of a public feeling against the extermination of these birds. It would be difficult to advocate anything like legislation. The most practical plan he had seen was this—that the Imperial Legislature should grant powers to the County Councils to protect known nesting-places in their districts for certain months of the year, say from April 1st to June 30th. Such a plan would be simple, and might be effective; but for one thing they should endeavour to do all in their power to help the owners and occupiers of land to protect the birds and their eggs during the breeding season. They might also see if they could not enlist the aid of the gamekeepers, who, with the farmers and proprietors, were beginning to find out that all birds were not their enemies. Collectors and dealers should also be discouraged. Just as he came there that day he had been told that 200 eggs of the stormy petrel had been taken from one island on the west coast of Ireland and given to one dealer.

Mr. E. B. Poulton, Oxford, said that if they discouraged the purchase of eggs, the trade of the dealer would soon cease.

Mr. G. J. Symons said it was an old saying that there would be no thieves if there were no receivers; and possibly there would be no dealers if there were no collectors. They should discourage as much as they could this spoliation of the nests of rare birds.

Mr. Mills, Chesterfield, thought it would do good if some small recognition were given to gamekeepers to assist in protecting the nests of the birds.

The Chairman asked if it would not strengthen the hands of Mr. Knubley if the meeting was to pass some resolution on the subject.

Sir Douglas Galton hoped any resolution of the kind would make an appeal to egg-collectors.

A Delegate suggested that it might do some good if the name of the Edinburgh gentleman with the 100 eggs of the golden eagle were published.

Mr. Whitaker suggested that the gentleman with the eggs should have the feathers of the birds also presented to him with the addition of a little tar. (Laughter.)

Mr. Knubley said he would submit a resolution at the next conference.

In Section E the Chairman remarked that last year there had been a discussion on the cost and antiquity of ordnance maps. Sir Douglas Galton said that a Departmental Committee was inquiring into the matter. Mr. Sowerbutts spoke of the badness of the teaching of geography in schools, giving examples from examination papers.

Flameless Explosives.—Prof. Merivale (in Section G) said he had nothing to report. The Durham strike had interfered with their arrangements, the proposed laboratories having been utilized as stables.

Under Section H Dr. Garson reported that there had been no applications to the Committee last year for aid in connection with anthropological exploration. He contended, however, that local bodies, when they meant to make such explorations, should give them notice. Valuable hints could be given them as to how they should proceed. Notice was also taken by Dr. Garson of certain anthropometric inquiries which were being conducted as to the effects on the health and physique of the public school system.

The Secretary, at the request of the Chairman, read an extract from a letter of Mr. Kenward, of Birmingham, giving particulars of an anthropometric laboratory established at Birmingham, like that of Mr. Francis Galton at South Kensington. Mr. Watts and Dr. Garson added a few remarks. The Chairman proposed that a claim should be made for the usual grant towards carrying on the work of the Corresponding Societies Committee, and the Conference adjourned.

SECOND CONFERENCE.—August 9.

The Corresponding Societies Committee was represented by Prof. R. Meldola (Chairman), and Messrs. Symons, Whitaker, Cuthbert Peek, Garson, Poulton, Rev. Canon Tristram, Sir Rawson Rawson, and T. V. Holmes (Secretary).

The Chairman made a proposal that in future some subject in which the delegates were generally interested should be brought as a short paper before the conference, such as the management of local museums, and the relations of County Councils to technical instruction, and the working of the Technical Education Acts. This was considered an excellent suggestion. Mr. Symons mentioned that he had arranged with Mr. Griffiths that delegates on the first day of the meeting of the British Association should be supplied with copies of the reports on subjects in which they were interested. This would give them longer time than they had at present to make themselves acquainted with the work which was being done. Mr. Robert Brown thought it would be a good thing if the printed report of the proceedings of the conference of delegates could be sent to the delegates earlier than at present. After some additional remarks from Mr. Cushing and the Chairman, the meeting proceeded to sectional work. In connection with the meteorological work in Section A, Mr. Symons spoke of the value of making observations on the temperature of underground waters, especially when new wells were being formed; and Mr. Whitaker remarked on the equally important point of the fluctuations of water in wells.

In Sections B and C there was nothing to bring before the Committee. When the work of Section D was reached an interesting discussion took place on the disappearance of native plants. Mr. Mark Stirrup began the discussion by reading a short note from an eminent Manchester botanist on the state of the district in that respect round Manchester. Mr. Sowerbutts, Manchester, said he believed the gentleman from whom the notes had been read was largely responsible for the eradication of rare plants round Manchester, inasmuch as he published a very charming book indicating where they were to be found. (Laughter.) Mr. Coates, Perthshire, said their Naturalists' Field Club, in publishing accounts of excursions or notices in papers of rare flora, only indicated generally where these were to be found. And Mr. W. Gray said that the Belfast Nat. Field Club acted in a similar way.

The Rev. Canon Tristram, Durham, next addressed the delegates on the question of making their field clubs more useful. He strongly advocated that these clubs should combine natural history, archæology, and geology; and that their function should be, not to destroy, but to preserve all that was rare and curious in a district. Lately their field excursions in many places had been too much of a picnic party. On the subject of local museums, the Canon argued that, as a rule, these should only contain objects of local interest, and he suggested that an approach should be made to the County Councils in order to get assistance for forming and keeping such museums in order. In regard to spoliation of districts of rare plants and ferns, the Canon advocated the formation of a public opinion on this question. On the question of the preservation from destruction of the eggs of rare birds, the Rev. E. P. Knubley, Leeds, moved the following resolution, which was seconded by Mr. E. Poulton, Oxford, and agreed to:—

"The conference of delegates, having heard of the threatened extermination of certain birds, as British breeding species, through the destruction of their eggs, deprecates the encouragement given to dealers by collectors through their demands for British-taken eggs, and trusts that the corresponding societies will do all that lies in their power to interest and influence naturalists, landowners, and others in the preservation of such birds and their eggs."

On this subject Canon Tristram also spoke, and put in a strong plea for the preservation of birds of prey—pointing to the case of the mice plague in Dumfries and Lanark shires as a result of destroying the balance of nature by wholesale killing of birds of prey. The resolution brought forward by Mr. Knubley was cordially adopted by the meeting.

In Section E Mr. Sowerbutts said that he should like to be able to communicate during the year with other delegates who were interested in geographical education.

In Section H Mr. E. W. Brabrook brought under the notice of the delegates the Ethnological Survey of the British Isles, which it was proposed to undertake by a committee of the Association on the suggestion of the Society of Antiquaries, the Folk-Lore Society, and the Anthropological Institute. Schedules would be sent down to societies, and he asked the co-operation of the delegates. Mr. Brabrook agreed with Canon Tristram in thinking that archæology should be one of the subjects of study of a field club. Mr. Whitaker said that in his district the Hants Field Club always did its best to protect antiquities; and Mr. Gray said that at Belfast the Field Club not only tried to preserve ancient remains, but also photographed them. Some of these photographs he exhibited. Canon Tristram mentioned the difficulties Field Clubs sometimes had with clergymen who were over-zealous in church restoration; and Mr. Tate (Belfast) alluded to the exertions of his society on that point; while the Chairman thought the clergy were not always as black as they were painted in this matter. Mr. Brabrook made some remarks on the best mode of making an archæological survey, pointing out the best sources of information, as regards the way of carrying it out.

Finally, Mr. Sowerbutts thought better terms might be obtained from the railway companies for delegates and others travelling to meetings of the British Association. The Chairman and Mr. Symons promised to represent the matter to the Council of the Association, and the conference adjourned.

SCIENTIFIC SERIALS.

THE *American Meteorological Journal* for July contains the following articles:—On the appearance and progressive motion of cyclones in the Indian region, by W. L. Dallas. The object of the inquiry is to see whether the cyclones of the Indian Ocean originate from the unequal distribution of temperature over and above the earth's surface. The author favours the assumption that cyclones are a production of the upper atmosphere, and thinks that the evidence, although far from conclusive, goes to show that (1) cyclonic storms descend from and retreat to the superior layers of the atmosphere; (2) the whirl may travel along in the upper atmosphere, giving only faint indications of its presence at the earth's surface; (3) the movements of cyclones agree generally with what may be supposed to be the movements of a superior layer of the atmosphere.—S. A. Hill, a memoir, by Edna Taylor Hill.—The eye of the storm (conclusion), by S. M. Ballou. The cause of the clearness of the eye is attributed by the author to the deficiency of the air at the outer edge of the calm, owing to the deflective force of the earth's rotation and the upward and outward movements of the air before reaching the centre; the deficiency being supplied by a gradual settling of the air over the whole area, thus dissolving the cloud stratum and showing the blue sky. The author admits that the discussion of the subject shows the need of more observations concerning the phenomenon.—Recent efforts towards the improvement of daily weather forecasts, by H. Helm Clayton. The author states in a clear and interesting form the various rules which have hitherto been established, and draws attention to a law of averages discovered by Francis Galton, which might with advantage be used in weather forecasting, for, although only applied by Mr. Galton to heredity, it is probably universal. For example, if a storm during a given twelve hours has moved with a velocity below the average, the probability is that it will move with a velocity one-third nearer the average during the next twelve hours.—The other articles are—on the sea breeze, by W. C. Appleton, and temperature sequences, by H. A. Hazen, being an inquiry as to whether, if the temperature has been high or low for a certain period, we may anticipate the contrary condition shortly. The inquiry does not seem to have led to any result which could be turned to practical use.

Bulletin of the New York Mathematical Society, vol. i., No. 10 (New York, the Society, 1892).—The opening article is a review (pp. 217-223) of "An Elementary Treatise on the Differential Calculus by Joseph Edwards" (2nd edition, Macmillan, 1892), by Miss C. A. Scott. Whilst the reviewer praises the "lucid and incisive style," the well-chosen words and the well-balanced sentences, she does not fail to make a slashing attack upon details, and to point out "certain specially vicious features." There is considerable force in Dr. Scott's criticisms, and it is probable that a careful consideration of them will enable Mr. Edwards still further to improve his, in many respects, excellent treatise. The remaining short contributions are a note on resultants, by Prof. Haskell; and collineation as a mode of motion, by Dr. Bôcher (originally delivered as a lecture before N. Y. M. Society (pp. 225-231). The usual notes, new publications, and index close the first volume of this new mathematical venture.

IN the *Botanical Gazette* for June, Mr. A. F. Foerste has an interesting paper, illustrated, on the Identification of trees in winter.—Mr. Charles Robertson continues his notes on the mode of pollination of American plants.—Mr. A. P. Morgan describes two new genera of fungi belonging to the Hyphomycetes, *Cylindrocladium* and *Synthetospora.*

IN the *Journal of Botany* for July, M. G. Massee describes and figures a new marine lichen from the coast of Scotland, *Verrucaria lætevirens*, and continues his description of new species of fungi from the West Indies.—Mr. W. H. Beeby argues in favour of the occurrence of natural hybrids among plants. In the number for August, Rev. E. S. Marshall supports the claim of *Cochlearia grœnlandica*, and the editor that of *Sagina Boydii*, to be considered as British plants; both are figured. In the continuation of his Notes on *Potamogetons*, Mr. Arthur Bennett describes two new species, *P. Delavayi* from China, and *P. tricarinatus* from Australia.

THE articles in the *Nuovo Giornale Botanico Italiano* for July are all geographical. Among them Dr. A. N. Berlese and Signor V. Pegliore give a monograph of the Micromycetes of Tuscany, 293 in number. The list includes several new species, and one new genus, *Phæopeltosphæria*, belonging to the Sphæriaceæ.—Signor S. Sommier commences a very interesting description of the physical features of the lower valley of the Obi in Siberia, with some account of its botany.

IN Nos. 5 and 6 of the *Bullettino della Soc. Bot. Italiana*, most of the articles are also of local interest. Signor A. Jatta describes a new genus of lichens, *Siphulastrum*, from Tierra del Fuego.—Signor E. Baroni gives a full description of the anatomy of the fruit and seeds of *Eugenia myrtillifolia.*—Signor L. Re contributes an account of the spherites found in *Agave mexicana* and other Amaryllidaceæ.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 22.—M. Duchartre in the chair.—Heat of combustion of some chlorine compounds, by MM. Berthelot and Matignon. The method of the calorimetric shell was employed for determining the heat of combustion of certain acid bodies. Monochloracetic acid, $C_2H_3ClO_2$, gave + 174·2 calories at constant volume, and + 173·9 at constant pressure, as the result of two combustions with camphor in presence of arsenious acid. The values obtained for trichloracetic acid, $C_2HCl_3O_2$, were + 106·3 at constant volume, and 105·4 at constant pressure. Trimethylene chloride, $C_3H_4Cl_2$, burnt in the presence of an equal quantity of camphor, gave a mean of 3·900 calories per gramme of the substance.—On glyoxylic or dioxyacetic acid, by the same.—M. Pasteur, in presenting to the Academy a work by Dr. Daremberg on Cholera, its Causes, and Means of Guarding against it, called attention to the following points: "Dr. Daremberg, in one of the principal chapters of his book, protests with great force against the pollution of the water-courses by drain-waters, and equally against the pollution of the soil by the distribution of these waters on the land under cultivation. He thinks that the germs of cholera, in the form of the bacillus which produces it, can remain living and virulent in the soil for several years, and eventually lead to the spread of the disease. Thus the cholera in the environs of Paris would have originated in cholera germs preserved since the last epidemic in 1884."—Thermo-chemical study of certain organic bodies with mixed functions, by M. Léo Vignon.—Quantitative determination of peptone, by precipitation in the state of peptonate of mercury, by M. L. A. Hallopeau. This method is claimed to be superior to the polarimetric, the calorimetric, and the absolute alcohol methods as being a complete precipitation admitting of more trustworthy measurements than the first, and less difficult than the second. A solution of peptone, which must be neutral or very slightly acid, is precipitated by a large excess of mercuric nitrate. The precipitate of mercuric peptonate, white, flocculent, and bulky, falls almost immediately to the bottom of the vessel. It is allowed to settle, and then poured on to a filter of known weight, washing with cold water until no precipitate is produced by sulphuretted hydrogen. The increase in the weight of the filter, dried at 106° to 108°, represents the weight of the peptonate of mercury; multiplying this by 0·666 gives the amount of peptone present. The mercuric nitrate is readily obtained from the "pure" commercial nitrate. Since this contains an excess of free nitric acid, which partially redissolves the peptonate of mercury, the acid must be removed by heating the nitrate with ten times its weight of water for fifteen or twenty minutes, filtering and heating to near boiling in a porcelain capsule. Then stir and add a few drops of carbonate of soda until the precipitate of oxide of mercury is no longer redissolved.—Etiology of an enzootic disease of the sheep, called Carceag in Roumania, by M. V. Babes. In the very fertile and often submerged islands of the Danube, where the shepherds from Roumania and Transylvania congregate, and where there are always hundreds of thousands of sheep, a disease occurs among them, especially in May and June, to which often a fifth of the herd will succumb, especially if it should have been brought thither from a distant pasture. It is an acute malady of a febrile nature, combined with hæmorrhage and œdema, and always with hæmorrhagic and sometimes necrotic inflammation of the rectum. In the red corpuscles of the blood are found round, immovable cocci, often undergoing subdivision. They are very similar to those observed in the corresponding cow-disease known in America as the Texas fever.—On a new chemical function of the comma-bacillus of Asiatic cholera, by M. J. Ferran. The growth of this microbe is always rapid and luxurious in the ordinary culture solutions; if they contain milk-sugar, it is incomparably more so; but the growth ceases entirely as soon as the solution becomes acid by the development of lactic acid, and the vitality of the microbe is extinguished. It seems reasonable to employ lactic acid in lemonade against cholera, and to aid its action by the anexosmotic power which morphin offers us; this substance would perhaps hinder the absorption of the toxic substances, and would prolong the action of the lactic acid by opposing its rapid elimination.

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THURSDAY, SEPTEMBER 8, 1892.

THE HIGHER THEORY OF STATISTICS.

Die Grundzüge der Theorie der Statistik. Von Harald Westergaard, Professor an der Universität zu Kopenhagen. (Jena: Verlag von Gustav Fischer.)

THIS is an important contribution to the Calculus of Probabilities and the higher theory of Statistics. The foundation of experience on which the whole edifice of probabilities is based has been strengthened and extended by the new material which Prof. Westergaard has deposited. Here, for instance, is one of his experiments:—From a bag containing black and white balls in equal numbers, he drew (or caused to be drawn) a ball 10,000 times, the ball being replaced in the bag and the bag shaken up after each extraction. He records not only the total numbers of each colour, but also the number of white balls in each of 100 batches, each numbering 100 balls, also in 50 batches each of 200 balls, and so on. The diminution of the relative deviation from the average as the size of the batch is increased comes out clearly. On an equally large scale Prof. Westergaard has observed the proportion of prizes to blanks in batches of tickets drawn at a lottery; and the frequency with which different numbers, drawn under conditions such that one number was as likely as another, were observed to occur actually. He has similarly tabulated the frequency with which the different digits 1, 2, 3, &c., terminate certain officially recorded amounts, the "kontis" of a savings bank, of which documents he has examined 10,000. These experiences afford new confirmation to the first principles of the calculus: namely, the fundamental fact of statistical regularity which the definition of probability involves, and the postulate that certain events are independent of each other in such wise that, if the probability of each be $\frac{1}{2}$, the probability of the double event is a quarter.

Ascending from these simple experiences, Prof. Westergaard reaches by a new and easy route the formula for the measure, or *modulus*, of the extent to which the observed number—*e g.* of white balls in a batch of 100 or 1000—is likely to differ from the most probable number; in the instance just given $100p$ or $1000p$, if p is the probability of drawing a white ball. The sought expression, it is presumed, must be a *symmetric* function of the probability of the event (drawing a white ball), which we have called p, and the complementary probability (drawing a non-white ball), viz., $1 - p$. This hint enables us to decipher from the records of experience that the modulus is proportioned to $\sqrt{p(1-p)}$. The influence of the *size* of the batch upon the extent of the deviation is similarly elicited from observation. Thus with a minimum of mathematical equipment, by easy steps and through an unpretentious *a posteriori* gate, we are led into the very stronghold of Probabilities—if not to the law of error itself, at any rate to one of its most important properties.

Prof. Westergaard has not only popularized the law of error, he has also proved it. He has added considerably to its evidence, by observing in an immense number of instances the exact correspondence between fact and theory. We must content ourselves with citing one set of instances. Ten thousand balls having been drawn at random, as above mentioned, and the composition of each batch of a 100 being examined, it was found that for twenty-five out of a hundred such groups the number of white balls lay between 49 and 51 (inclusive)—limits distant ± 1 from 50, the most probable number. For forty out of the hundred groups the number of white balls lay between the limits 50 ± 2. And so on. The observations are exhibited and compared with theory in the annexed table:—

Number of batches in which the number of white balls is between certain limits.		Limits.
Observed.	Calculated.	
25	24	± 1
40	38	± 2
50	52	± 3
70	73	± 5
85	87	± 7
95	96	±10

The multiplication of correspondences like this, the concatenation of evidence in favour of the law of error which the author has put together in his fifth chapter, is very cogent.

Another sort of verification to which the law of error is submitted is to compare it with the explicit binomial to which the exponential law is an approximation. This approximation is closer than may be supposed. For example, if a hundred balls be taken at random, each ball being as likely to be black as white, the probability of obtaining exactly 50 balls, as evaluated by the binomial theorem, is ·080, as approximately determined by the exponential law of error is also ·080. The probability of obtaining either 49, 50, or 51 is, according to the exact calculation, ·236, according to the approximative formula, also ·236. And so on.

Among other contributions to the calculus which Prof. Westergaard has either adduced from authors rarely read, or himself deduced, may be noticed his elegant treatment of the case where the probabilities of two alternative events (say, drawing white or black balls) are not equal (p. 70). Suppose that the probability, say p, of one event is very small, then the formula for the deviation of the number of white balls actually drawn from the number most likely to be drawn, viz. np, admits of simplification. The "mean error" ($=\textit{modulus} \div \sqrt{2}$) is in general ... ($\sqrt{np(1-p)}$); in the particular case it becomes approximately $\sqrt{np}$. A further simplification may be explained by an example. Suppose that we know the number of deaths, say 900, per unit of time in a certain population. Then, without knowing the number of the population, or without taking the trouble of referring to it and calculating the death-rate, we may determine approximately the fluctuation to which the number of deaths is liable. For the measure of that fluctuation the "mean error," is approximately $\sqrt{np}$; n being the number of population, a large number, and p the death-rate, a small fraction. Now np is 900, and accordingly 30 is the mean error, that is, assuming that the urn in which the lots of Fate are shaken—"omnium Versatur urna serius ocius Sors exitura"—is constituted as simply as the urn in which we have supposed black and white balls to be shaken up. This is a question in Applied Probabilities to which we are just coming.

Prof. Westergaard's applications of the calculus to statistics are even more striking than his developments of the pure theory of probabilities. The law of error may be applied to concrete phenomena in two cases: where the fluctuation of averages follows the analogy of the simpler games of chance—as we just now assumed with regard to deaths—and where this condition is not fulfilled. Prof. Westergaard's contributions belong chiefly to the first class. He has considerably added to the instances discovered by Prof. Lexis, in which a set of ratios—such as the proportion between the mortality of male and female infants in different years—are grouped according to the same law of dispersion as the percentages of white balls in a set of batches drawn at random from an urn containing black and white balls mixed up in a certain proportion. The uses of this discovery are twofold—negative and positive. In the first place, we may be deterred from a search after causes which is hopeless. In the typical instance of the urn and balls it would be vain to trace the reason why any particular ball, or set of balls, extracted should be white (or black). We cannot hope to analyse the "fleeting mass of causes"—as Mill calls Chance—upon which the event depends. We may have been able to break up our batches of balls into two classes, say rough and smooth, such that the rough balls are extracted from an urn containing mostly white, while the smooth balls are more frequently black. But when this process of "depouillement" has been carried as far as possible, when we have reached the ideal type of a single urn and constant proportions, then the investigation of causes halts. Then it is only crazy gamblers who hope to discover a principle underlying the "runs" of black and white balls. We have reached the bounds of the territory of science; beyond there is only the sea of chance. Prof. Westergaard has not only indicated this limit, but also pushed many of his investigations up to it.

These considerations do not preclude us from applying the theory of error to detect delicate distinctions such as the difference between a loaded and a perfect die, which make themselves felt in the averages of great numbers of observations. In fact, it is by the mathematical method that we can best determine whether a difference between two averages is significant of a real constant difference, or only apparent and accidental. Prof. Lexis, and Dr. Duesing after him had applied this method to the investigation of the conditions under which the excess of male over female births is greater or smaller than usual. Prof. Westergaard shows that the method is applicable to many other subjects, among which the mortality at different age-periods promises to be most useful. We could wish, indeed, for more copious evidence in favour of the premise that the mortality of a population at a certain age-period (say of clergymen or innkeepers between the ages 35-44. See *Grundzüge*, p. 82, with context, and *cf.* p. 52) fluctuates according to the analogy of games of chance.

Here the question arises: must the phenomenon under consideration be known to vary after the manner of balls extracted from an urn, in order that the mathematical method may be applicable? Certainly the apparatus of the law of error—probable and improbable deviation—may be employed to ascertain whether the difference between the average heights of two groups of two men is significant or accidental; though in this case the modulus (or mean error) does not follow the analogy of the simpler games of chance. Might we not similarly compare the *general* mortality of two sections of population, although the dispersion of such death-rates about their average is much greater than it should be on the hypothesis of pure sortition. The advantage, indeed, which we have above distinguished as negative, would no longer exist in this case. But might not the positive advantage still be enjoyed in some degree? Prof. Westergaard, so far as we have observed, is silent on this topic.

We have left ourselves too little space for noticing Prof. Westergaard's other contributions to applied Probabilities. His treatment of Insurance, together with the adjacent theory of Life-Tables, involving the arts of Interpolation, may dispute with Cournot's classical chapters the honour of forming the best introduction to the subject for the general reader—the reader prepared by a general mathematical, as distinguished from a special actuarial training. Nor must we pass over the chapter in which the author surveys "economic" (exclusive of Vital) statistics. He has here occasion to employ largely the important principle of inference from samples. For instance, in order to discover the amount of wood in a country, we should first select one or more sample surfaces (*Probe-flächen*), and a sufficient number of sample trees thereat, and then measure the quantity of wood on those trees. "From the figures so found conclusions can be drawn as to the whole sample-surface, and from those to the total quantity of wood in the country." So in order to determine the quantity of milk, we must proceed by way of *Probe-kühe.* The method of samples is no doubt a potent instrument when wielded by a trained hand like Prof. Westergaard's. We may perhaps extend to economics generally what he suggests with reference to its statistical side: that a given effort and expense may be better laid out in obtaining a detailed knowledge of a few parts with a general view of the whole, rather than a more uniformly distributed information.

The last part of the work is devoted to a history of statistics; not a chronicle, but such a history as a great tactician would write of past wars. The criticism of Quetelet's methods is particularly instructive. In connection with Quetelet we may note—without assenting to—one of the Professor's objections to the principle of the "Mean Man." It is in effect the same objection as Cournot raised: that the average of one limb derived from measuring several specimens might not fit the average similarly found as the type of another limb. The model man constructed by putting together these averages of parts might prove to be a monster.

In conclusion we venture to express the hope that this important treatise may be translated into English; in order that the insular student may not have to encounter the difficulties of German and Probabilities at once. We might advise the translator to follow the excellent English custom of prefixing descriptive headings to all the tables. As they stand, a close attention to the context is sometimes required in order to be quite certain of the principle in which figures referred to as "calculated" have been obtained. We refer chiefly to the fourth chapter. There occur also, in the second chapter, some terms vital to the meaning, which may require to be interpreted for the benefit of the English reader; e.g. *Zahlenlotto*, *Klassenlotterie*, *Kontis* relating to the *Sparbank* "Bikuben" in Kopenhagen.

F. Y. E.

THEORETICAL PHYSICS IN ITALY.

Trattato di Fisico-Chimica secondo la Teoria Dinamica. Opera Postuma di Enrico dal Pozzo di Mombello. (Milano, 1892.)

THIS is an elementary treatise from the hand of the late Prof. Mombello, of the Free University of Perugia. In the general nature of its contents it might be compared to Prof. Ostwald's *Allgemeine Chemie.* It is, however, much smaller; and is indeed less of a systematic treatise than a condensed statement of the many principles and laws on which physics and chemistry are built. The English terms physics and chemistry have, under the influence of our examination systems, become so stereotyped in meaning that neither term could fitly describe the character of this *Trattato di Fisico-Chimica.* The time-honoured division of subjects would ill fit into its plan. Dynamics, properties of matter, heat, light, sound, electricity, and magnetism are certainly all treated in their more theoretical aspects; but there are also introduced the laws of chemical combination and the atomic theory, which give the book a character possessed by none of our English treatises on physics. A brief sketch of its character may not then be wholly valueless.

The treatise is divided into five parts, under the headings *Dinamica*, *Azione Moleculare*, *Elettrologia*, *Luce e Colore*, *Filosofia Scientifica.*

The first part contains much that we understand as Dynamics; but it contains a good deal more. In chapter I. (*Moto ed Energia*) physics is described as the science of motion. The universal law of nature is the law of causality, after a brief discussion of which we are introduced to four general principles—namely, the law of the conservation of mass, the law of the equality of action and reaction, the rectilinear action of force, and the composition of motions. Then follow two *General Physical Laws*, the conservation of energy and the transformation of energy (*la correlazione ed equivalenza dei moti*). Thereafter are introduced somewhat less general formulæ, which are distinguished as *Definite Physical Laws* and *Definite Chemical Laws.* Of the former, two examples are given—namely, "Pascal's Law" concerning the transmission of pressure in a liquid, and "Dalton's Law" that there is no physical action between the particles of gases, which are not chemically combinable. Then of the definite chemical laws four are particularised, being distinguished by the names of Lavoisier, Proust, Avogadro, and Cannizzaro, the last being a modified statement of Dulong and Petit's law of the specific heats of the elements. The rest of the chapter is devoted to a discussion of inertia, of Newton's laws of motion with special reference to the second interpretation of the third law, of kinetic (*attuale*) and potential energies of action at a distance, and of the conception of stress (*conflitto*) between particles. Chapter II. (*Composizione dei Moti*) is purely kinematical. In chapter III. (*Velocità moleculare*) the physical molecule is led upon the stage. Cohesion, viscosity, rigidity, porosity, volatility, critical points, crystalline form, and gravitation—in a word, the essentially molecular and *dynamic* qualities of bodies—are touched upon; and the whole finishes with an elementary treatment of the kinetic theory of gases, including an account of Crookes's experiments on radiant matter. It is satisfactory to notice that Prof. Mombello, like Prof. Ostwald, has the boldness to speak simply of Boyle's Law untainted by the Marriotte blend. This, of course, is merely historic justice. On the other hand, surely Herapath deserves mention as one of those who aided in the development of the kinetic theory of gases.

This early introduction of the kinetic theory has no doubt its merits; but a more logical course would have been to give in the first place some notion of the real meaning of temperature. This is touched upon in the immediately succeeding chapter, *Teoria termo-dinamica*, which forms Chapter I. of Part II. The treatment here is certainly peculiar. Two theorems (*enunciati*), we are told, are to be taken for the study of heat. The first embraces Carnot's doctrine of the logical necessity for a complete cycle, and his great principle of the reversibility test. Lord Kelvin's definition of temperature is brought in as a kind of corollary and dismissed in a few sentences. We hear no more of Carnot. "The second *enunciato* is concerned with the fact that in the universe an immense indefinite quantity of heat is being generated constantly during the formation of the stars." Then follows a brief sketch of some of the conclusions of spectroscopy, leading up to a broad discussion, in terms of the molecular theory, of the meaning of temperature, and of radiant energy in its four-fold aspect—thermal, luminous, chemical, and phosphorescent. After this thermodynamics, in the usual significance of the term, is presented under the guise of two propositions ascribed to Hirn. These propositions are, to all practical intents and purposes, simply the two laws of thermodynamics. But we search in vain for any reference to Joule; while Rankine and Clausius are merely mentioned as having proposed a demonstration of Hirn's second principle! Now Hirn deserves all credit for his experimental corroboration of the truth that only a fraction of the heat which leaves the boiler is transformed into useful work; but to magnify his labours in the way indicated is surely an inversion of history. Moreover there is no hint as to the relation between Carnot's reversible engine and the second principle; and the absolute zero of temperature is defined only in terms of the gaseous laws. Of entropy and the dissipation of energy we find no trace.

The succeeding chapters of Part II. are devoted to such subjects as the atomic theory (chemical) and the various aspects of capillarity, diffusion, osmose, &c. A brief account is also given of electro-chemistry, although electrical phenomena in general are not discussed till later. The seven chapters of Part III., in which electricity and magnetism are treated, form a highly condensed and instructive compendium of fact and theory, the two not always, perhaps, very clearly distinguished.

Chapter V. is concerned with "The Induction Balance of Hughes"; and here, for the first and last time, we encounter the name of Joule, who appears as the discoverer of the elongation of iron in a magnetic field. This is, of course, thoroughly accurate; but why, we naturally ask, is there no mention of Joule's Law of the heating accompanying conduction of electricity? The whole question of resistance is, indeed, barely touched. It is difficult to imagine by what process of reasoning such an important subject is omitted in a book which positively bristles with laws and principles named after their discoverers.

This method of cataloguing physical laws—for it is little else at times—has its advantages, especially from an examinee's point of view. It is doubtful, however, if it can be carried out consistently. Prof. Mombello certainly has not done so, although in the majority of cases he seems to be historically sound. One objection to the method is that, as it is impossible to group physical principles, like geometrical propositions, in a logical series, and as physical principles belong to different axiomatic, experimental, or hypothetical grades, there is a strong tendency, in a compendium of the kind we are reviewing, to present these principles in a false perspective. There is no doubt, however, that Prof. Mombello has placed in the hands of the countrymen of Galilei an instructive and suggestive treatise bearing on the varied phenomena of molecular physics. There is editorial carelessness in the spelling of foreign names, and serious faults of omission of the character discussed above. But the teaching is in general sound, and Part V. fitly closes with an account of Maxwell's electromagnetic theory of light, and a discussion of the character of the ether.

C. G. K.

THE MICROSCOPE IN THE CLASS-ROOM AND LABORATORY.

The Microscope and Histology for the use of Laboratory Students in the Anatomical Department of the Cornell University. By Simson Henry Gage. Third edition. Part i. (Ithaca, New York, 1891.)

THIS is a practical handbook by a thoroughly practical histologist. It is an expansion of an earlier and more concise treatise, written not for the amateur and the dilettanti, but for the laboratory student.

The recognition of the need of such a handbook is in itself an evidence of the practical character of its author, and of his knowledge of the wants of the serious student. To follow intelligently the best and most suggestive histological teaching requires more than a passing or perfunctory knowledge of the use of the microscope; and this can only be really acquired by those who have at least an elementary knowledge of the principles upon which this now really complex instrument is constructed. It has become an instrument of precision, and precise methods must be adopted in its use. This does not mean that it is more difficult to use than it was in the early years of the last quarter of a century; but it only implies that the principles upon which it is to be successfully employed should be thoroughly understood and practised.

Thus the apochromatic system of lens construction is an immeasurable gain, an improvement so great that its amount cannot be exaggerated; and these lenses are, if anything, rather easier to use than those of the older achromatic construction; but if the principles of their construction, and consequently the principles involved in the employment of them, be not understood and carefully practised, they yield results entirely unsatisfactory.

Again—and this is a point not referred to by Prof. Gage—those who may be provided with a good battery of achromatic lenses, and do not desire to face the cost of changing these for a series of apochromatics, may come wonderfully near the best results of the finest apochromatic objectives by the use of real monochromatic light. To obtain this with complete certainty, using any monochrome of the spectrum we may desire, with good lamplight, is now not only possible, but easily within the reach of all, and in such a manner as to lend itself to employment with the condenser and any magnifying power it may be needful to apply; and by this means not only is a good achromatic lens, as it were, elevated optically into an "apochromatic," but its numerical aperture is increased—the great desideratum, all else being equal, of good optical performance.

These are indications enough to emphasize the importance to the medical student generally, and to the histological student in particular, of a book that will briefly and accurately give him a knowledge of the principles involved in the construction and employment of the microscope, upon his intelligent use of which so much depends, but to which, as a rule, so little time is devoted, and therefore so little knowledge is possessed.

We do not for a moment suppose that a treatise like this, however well conceived and carried out, can give efficient, to say nothing of exhaustive, knowledge of optical theory, principles, and the laws and conditions of construction so as to enable a student to become in this sense a master of microscopic manipulation and interpretation; but it will go far to enable him to go through his work as a student with an intelligence and insight otherwise unapproached; and what is still more important, it will give him the opportunity of acquiring ability to see in the preparations he is instructed to make, or which he is required to study, or which he makes of his own initiative, that which he is *not* directed to look for, and which may open up for him and his science new and important paths. But this cannot be done if the student is not, in a strictly scientific sense, using his instrument, and is therefore approximately certain of the propriety of the interpretation of what he has been able to make out in his preparation.

Prof. Gage has adopted a system of illustrations (which we think might have been of a more refined artistic character, with much advantage) which are concisely and in the main accurately explained, and are intended to cover the entire subject; definitions, descriptions, and textual illustrations are added, which, taken together give a completeness to the treatise, that thoroughly fit it for its intended purpose. In many points it is as a matter of necessity, from its very nature, inefficient. It can only indicate, and not exhaustively explain, many most important points. But to the intelligent student alive to his subject, these are but spurs to further reading; and the larger treatises, giving full explanations of the matter in hand, will not be long unread. In short this treatise lays the foundation for a thorough microscopical training, entirely adapted to the wants of medical students.

It is printed only on one side of the page throughout, so that the blank page is open for notes, and by using the opportunities presented with wisdom, the book may acquire, in the hands of an industrious student, a doubled value.

We may note that there are some points that even with the restricted object of the book we think might have received fuller, or even more accurate treatment. A fuller treatment might certainly have been given to the subject of "oblique light," which is very lightly touched; but which is none the less, to the partially instructed, whether medical student or ordinary amateur, one of the most prolific and frequent sources of erroneous judgment and entire misinterpretation; and we believe that no treatise on microscopic work, whatever its object, can be thoroughly efficient without giving it grave and careful consideration.

On the other hand it would have given greater value from the point of accuracy if the details given for the "Centring and arrangement of the Illuminator," by which is meant the sub-stage condenser, had been of a somewhat later period. On the use—the right use—of the condenser much of the best English work of the past quarter of a century has been spent. Happily German microscopists and opticians have during the past seven or eight years begun to perceive the value, nay, indispensable importance, of this apparatus, and the firm of Zeiss have, through Abbe, made successively chromatic, and subsequently achromatic condensers of increasing value. We trust they may be induced to follow English opticians and make apochromatic condensers, especially one adapted in numerical aperture to their latest optical triumph in lenses, viz., that possessing a N.A. of 1·60; the full value of which as an apochromatic objective can never be seen without it. It is a pleasure to note that Prof. Gage tells us that "for *all* powers, but especially for high powers," the condenser is of "great advantage." We believe it for the highest results, even with "low" powers, to be indispensable. But it will never be by the employment of "a pin-hole diaphragm . . . put over the end of the condenser" so that this aperture shall appear in the middle of the field, that the best possibilities of the condenser will be reached. The student is plainly told that the "optic axis of the condenser and of the microscope should coincide," but the best way of securing this coincidence is certainly not stated.

The blemishes of the book are nevertheless few, it has a decided purpose, and there is a large sphere for its action. We believe that another edition will not long hence be called for in which its author will not find it difficult to emend and expand it in certain parts, and possibly still further to enlarge it, and we will add that we think it may not only prove of value to the students in the Anatomical Department of the Cornell University, but also to others on both sides the Atlantic.

W. H. Dallinger.

OUR BOOK SHELF.

An Elementary Text-book of Magnetism and Electricity. By R. Wallace Stewart. Univ. Corr. Coll. Tutorial Series. (London: W. B. Clive and Co., 1892.)

In this work Mr. Wallace Stewart presents us with another of his excellent text-books on elementary science. Just as his treatment of the subject was concise and clear in his book on heat and light, so here he has followed the same lines, and has placed before the student, especially one who is preparing for the matriculation examination of the London University, a course in magnetism and electricity which will give him a thorough knowledge of the subject and a sound basis on which to make further study. The illustrations and diagrams will be found to form a valuable addition to the text, while the numerous examples at the end of each chapter, if thoroughly worked out, should give a student a good insight into the art of solving problems.

Key to Arithmetic for Beginners. By J. and E. J. Brooksmith. (London: Macmillan and Co., 1892.)

This key will be welcomed by all those who are employing Mr. Brooksmith's excellent arithmetic. It has been prepared especially for the use of teachers, who will find it a valuable aid in their work, but no doubt it will be largely demanded by those who are studying this subject for themselves, for much may be learnt by a judicious use of such a book. The examples, so far as we have been able to see, have been very carefully and concisely worked out, and many difficulties that usually arise have here received careful attention.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

International, Geological, and other Records.

My friend Mr. Minchin's letter has opened a question that I have been ruminating for a very long time. We occasionally hear of the organization of science, but the very ABC is at present neglected, or carried out in a spasmodic and disjointed manner. Let us take for example geology. We have several attempts at a catalogue and review of its yearly literature, of which I give the following examples. First comes the "Geological Record," a publication very well in its way, but making its appearance at irregular intervals, and often much behind time. We have in Prof. Blake's Annual the attempt of a single individual to cope with a mass of literature that it is impossible for him to read, and treating of questions that no single person is or can be qualified to deal justly with. The very obvious result of this is careless reviewing, and general dissatisfaction of most authors whose papers are submitted to the abstracting process. I hope Prof. Blake will not take these words as a disparaging appreciation of his attempt, which I think does him much credit as a single-handed worker, but it will not satisfy the geologists in general. Next we have the "Annuaire Géologique Universel," for which great credit is due to Drs. Carey and Agincourt. Here we have the geological literature of each country treated separately, followed by a subject literature. Each article is compiled by a specialist in his own branch, and one who is able to form a just opinion of the work and appreciate the salient points of it. Altogether the organization of the "Annuaire" is on the right lines, but I understand it is not a financial success, and I have very grave doubts if it will continue, because the supporters of one publication cannot be the supporters of several. The motto "L'union fait la force" is as true in this case as in any other. Then again there is not that official character about it that there would be with international co-operation, supported by governments, scientific societies, &c. As two years' collaborator for the subjects of seismology and vulcanology I can give some of my experiences. In the first place it means a very big slice of time to read (for without this the thing had better be left alone) and review the annual literature of such subjects; for this there is no recompense whatever, but as I shall show actual money out of pocket. It is impossible for the reviewer, unless residing in such towns as London, Paris, or Berlin, to see all the literature of his subject. He, therefore, has to send out circulars, the expenses and postage of which, without counting labour of addressing, I found to come to about 2*l.* annually. A considerable proportion of these circulars are not even answered by those who have published papers on the subject during the year, and I am sorry to say that in one or two cases I have had a reply insinuating that I had been "*cadging*" for a copy of the author's paper or book. After the review is published come protests from authors (not many in my case, fortunately,) whom, out of common courtesy, time and money must be spent in answering. Finally, with every care such a work is far from complete. I would, therefore, hazard the following propositions:—A preliminary committee to be formed as soon as possible to study the question of international records of scientific literature. That such committee should determine the language of such records, the methods of organization of each separate subject committee, the means and resources of such, and invite the co-operation of other nations.

To my mind each record committee—say, for example, that of geology—should invite the specialists who are willing to collaborate to do so, should examine their manuscripts before going to print, keep a list of all known workers in that particular branch, and find as many subscribers to the work as possible. The central committee should nominate the subject committees, treat with governments, societies, and universities for support, and keep a loose card catalogue of all scientific investigators in the world, to whom should be posted annually a circular requesting the dispatch of their publications, if possible with a short abstract by themselves, to the reviewer of their special subject, the names and addresses of whom should be appended to the circular. In this way reduplication of reviewers circulars would not take place; and if a botanist wrote a paper on an earthquake, for example, he would be reached by the application from the vulcanologist as well as by the botanist. Finally, should profits accrue in the future, I would suggest that they be equally divided annually amongst the reviewers. I really hope that the subject will be taken by the horns before we reach—and we are near—a great scientific literary deadlock.

Harrogate, August 30. H. J. Johnston-Lavis.

A Suggestion for the Indexing of Zoological Literature.

It is obvious that the numerous records of all sorts which comprise the zoological literature of each year are only of use so far as we have access to and knowledge of them, and that their existence is actually a very serious encumbrance to those workers who are unable to make use of them.

It is self-evident that sooner or later, if zoology is to be preserved from chaos, every fact of any importance will have to be indexed for reference. Otherwise, nearly the whole lives of zoologists will come to be spent in libraries, until the thing gets so intolerable that some one suggests that we burn all the books, and start afresh from nature.

Of course, a great deal of indexing has been done, and is being done. The "Index Gen. et Spec. Anim." is well on the way, and the "Zoological Record" and other works of a like nature appear annually. But these are mainly records of names of species and genera described as new, and the "Zoological Record," admirable and invaluable as it is, is not always complete, nor in some sections (notably the last on mollusca) entirely accurate. Much indexing is continually being done in monographs, such as the Brit. Mus. Catalogues, and the value of this work can hardly be over-estimated, but here again it mostly relates to *species* as such. Then there is the Royal Society's "Catalogue of Scientific Papers," which is good so far as it goes, and the still more perfect Engelmann and Taschenberg. Putting aside, for the present, the question of indexing past records, would it not be a great advantage if we could begin now, and index everything as it appears? Possibly this could be done on the following plan:—

Let a society be formed, called, say, the Zoological Index Society, consisting of all writers on zoological subjects who will join.

The members of the society to be provided with uniform record slips at cost price, on which they will undertake to record *everything* in their writings that they believe to be important or new. These records might be under various heads, *e.g.*, the "semi-melanoid variety" of the leopard, described to the Zoological Society on November 20, 1883, might be indexed under *Felis pardus*, under *Melanism*, and under *Cape Colony*.

These slips to be sent to the secretary of the society, who would arrange them in alphabetical order, in cabinets provided for the purpose. The slips, under each special heading (*e.g.*, Species, Higher Groups, Variation, Distribution, &c.) would form continuous series. The slips of each year might be kept separate for six months, and then merged in the general index.

The members would be required to pay a subscription sufficient to cover the expenses of the above; but it would probably be possible to obtain assistance from some of the scientific societies, and the most suitable place for the index to be kept is doubtless the Natural History Museum. If this were accomplished, it would still be desirable to raise further funds, in order to increase the utility of the index in the following ways:—

(1) By obtaining an assistant secretary, whose duty it would be to copy out records from the index for workers residing in the country or abroad, at a certain small charge. The applicant might ask, *e.g.*, for *Limax*, or Jamaica, or Albinism, and would pay according to the number of records.

(2) By publications. Possibly some arrangement might be made with the Zoological Record Committee, and special publications containing the records relating to matters then of interest might appear as often as possible.

Volunteer work in indexing earlier works would be acceptable. Thus, some admirer of Darwin might be willing to index the works of that author. But in such cases a careful list should be kept of the books indexed, and every index should be complete. Presumably no one will dispute the utility of an index as proposed, but some may doubt the possibility of getting sufficient co-operation. If the idea of such an idex became familiar to writers, it can hardly be doubted that each would desire to place his writings on record along with the rest. If a man's writings are not worth this trouble, they are surely not worth printing, unless, of course, they are of such a nature (*e.g.*, educational works) as not to require indexing in this manner. T. D. A. Cockerell.

Institute of Jamaica, Kingston, Jamaica, August 15.

Rain with a High Barometer.

In Nature of September 1 in your note on the Annual Report on the Royal Botanic Gardens, Trinidad, you emphasize the fact that at Trinidad it always rains with a high barometer.

This is a not uncommon phenomenon in other parts of the world. Last year I made a series of meteorological observations in Mashonaland, and more especially while stopping during June and July at Zimbabwe, and I there found that a high barometer was invariably accompanied by rain, and the higher the barometer the more certain and heavy was the rain. The atmosphere was driest when the barometer was lowest, and then the difference of the readings of the dry and wet bulb thermometers sometimes exceeded 20° F.

This state of climate in Mashonaland is I think mainly due to the configuration of the country, which is such that moisture can only be carried there by southerly and south-easterly winds, and they—as winds blowing towards the equator generally do—increase the atmospheric pressure.

It will be interesting to know if some such explanation will not account for the condition of things in Trinidad, and if any of your readers can tell of a similar state of climate elsewhere.

Robert M. W. Swan.

15, Walmer Crescent, Glasgow, September 3.

The Perseids.

With reference to the note, August 18th, that no news of the Perseids had then come to hand, I fancy the shower must have been fairly bright this year. One of our scholars, C. E. Elcock, while crossing from Belfast on the 9th, saw some bright meteors in ten minutes between 9 and 9.30, one lasting some time. Afterwards only occasional ones occurred.

J. Edmund Clark.

Bootham, York, August 29.

Variable Star T Cassiopeiæ.

FROM long-continued observations of the above star, irregularities in the ascending light curve may be expected about October or November next. I shall be happy to supply a diagram of the field to any one interested in the question.

CUTHBERT E. PEEK.

Rousdon Observatory, Lyme, September 5.

THE OPPOSITION OF MARS.

THE *Times* of Saturday contains a most important telegram, giving the results of Prof. Pickering's observations in Peru during the present opposition of Mars, which is one of the most favourable which has occurred during the last half of the present century. The work done at Arequipa in one respect contradicts, and in others goes far beyond, the results recently announced from the Lick Observatory. There can be no doubt that a considerable advance has been made by this year's results; many prior observations which have been considered doubtful have been confirmed, and an additional interest lent to the observation of the planet.

The time, therefore, seems opportune for considering several questions connected with Mars, and it will be convenient to begin with the conditions of this year's observations, especially since the least astronomical among us has certainly noted with surprise the bright red star which now nightly rises low down in the south-east. Nor will he or she be less inclined to regard it when it is recognized as the planet about which during the last month so much has been written of human rather than of astronomical interest. If everything that one sees in print be true, the inhabitants of Mars are signalling to us, and it only remains for us to choose our manner of reply. Of course from signals the imagination of the ready writer has passed at once to words, and having got so far, each planet is about to become acquainted with the history and present conditionings of the other by means of a language understanded of our neighbours as well as ourselves.

But first as to the cause of its excessive brilliancy during the last month or so, for this doubtless has had something to do with the present general interest taken in the planet. Mars was as bright in 1877, but on that occasion nothing like the present amount of interest was taken in its movements and possible structure. For this there are two obvious causes—one the increasing interest taken by people in science generally; the other, popular glosses on several recent discoveries made regarding Mars itself.

The popular idea that the changes which have been recently observed on the planet are changes due to the work of its inhabitants—an idea based upon a mistranslation of a word—has, of course, generated the other one—namely, that vast operations have been undertaken for signalling purposes; and from this idea the step to Mr. Galton's or Mr. Haweis's method of signalling back is a small one. Small though it be, however, the public interest has thereby been greatly enhanced.

One of the most serious suggestions in modern times regarding signalling to bodies outside the earth we owe to a German astronomer, who some while ago enriched the world with the idea that the inhabitants of the Moon might possibly be communicated with by establishing on the vast plains of Siberia geometrical figures, such as circles, &c., built up of fire-signals, to which signal, if seen, the Lunarians would reply by reproducing them.

Then the popular mind was content to bridge the chasm of 240,000 miles which separates us from the moon. But *now* Mars is the objective—Mars, which at its nearest approach is 35,000,000 of miles removed!

…t Mars when in opposition may be very much further away than that; so far, indeed, that it is then observed to be 1-5th of its maximum brightness, and naturally with very reduced angular diameter. The two preceding oppositions at which its brightness has been at all comparable to its present one, took place in 1860 and 1877, so that we find the most favourable oppositions about sixteen years apart. The reason of this will easily be gathered from Fig. 1, which shows with sufficient accuracy the very elliptic orbit of Mars in relation to that of the earth. The lines joining the two orbits are those connecting the two planets during some oppositions from 1830 onwards to 1871. The outer planet, Mars, is represented nearly at the *perihelion* part of its orbit, that is the point at which it is nearest the sun (and therefore the earth, if we treat the earth's orbit as a circle), and the reason that the 1830 and 1862 observing conditions were so much better than those of 1869 and 1871 is at once clear. The opposition of 1877 and the present are not shown on the diagram, but they occurred at a time when Mars was not far from its perihelion.

The diagram also allows us to see that at the perihelion point of Mars' orbit the planet is very nearly at the time of the southern solstice, the N. pole being inclined away from the sun. Also that this must occur about four months before the southern solstice of the earth, the direction of the axis of which is also shown.

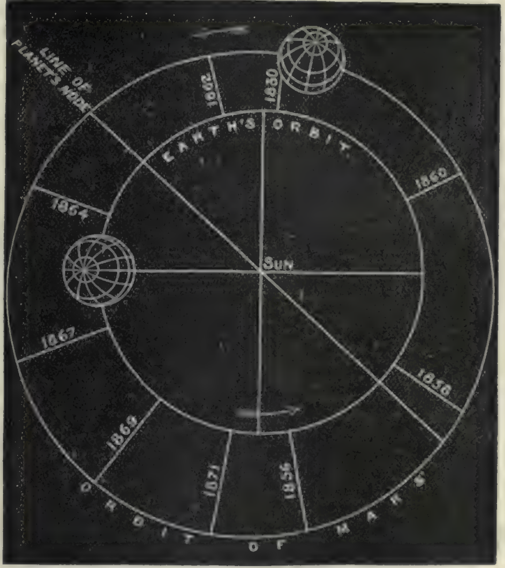

FIG. 1.—The orbits of the Earth and Mars.

So that at an opposition which occurs in August, as the present one does, we observe what happens in the summer solstice of the northern, and winter solstice of the southern, hemisphere of the planet. In fact, generally we have:—

Time of opposition.	N. hemisphere.	S. hemisphere.
August	Winter	Summer
November	Spring	Autumn
February	Summer	Winter
May	Autumn	Spring

The perihelion point of a planet's orbit is astronomically expressed by its heliocentric longitude, and the apparent size of its disc (on which its apparent brightness depends) by its semi-diameter in seconds of arc. Presuming that the longitude of the perihelion of Mars may be taken as about 334°, the following table will show how the great brilliancy of the planet in 1877 and the present year was caused; other less favourable oppositions are given for purposes of comparison:—

Date of opposition.	Semi-diameter.	Heliocentric longitude of planet.
	″	°
1862, October 5	10·8	12
1869, February 13	8·2	145
1873, April 27	9·7	217
1877, September 5... ...	**14·7**	**343**
1881, December 26 ...	9·2	95
1884, January 31	8·3	132
1888, April 10	9·2	201
1892, August 13	**14·7**	**312**

So much, then, for the distance conditions. At its nearest approach the planet is 35,000,000 miles removed—let us say 150 times more distant than the moon.

We next come to the conditions of visibility. Mars is nearest to us (the degree of nearness depending upon its position in its orbit) when "in opposition," as we have said—that is, when it is in the south at midnight, and opposite the sun, the sun then being, of course, due north below the horizon. It will then appear to us "full," as the moon is said to be full when she occupies an analogous position. At this moment, then, the earth is invisible to the inhabitants of Mars unless she happens to transit the sun's disc.

The earth appears to Mars precisely as Venus does to us, and if inhabitants there be on Mars, and they study astronomy, a transit of earth to them will be what a transit of Venus is to us.

Further, as we see Venus as a half-moon, and when nearer to us as a fine large crescent, so the Martians, as the earth approaches them, will see her as a half-moon and then as a crescent, getting finer as the apparent diameter of the completed circle gets greater.

Mars, to see us best, must occupy a point near its perihelion. These things may be gathered from Fig. 2, in which an opposition at Mars' perihelion is shown, the orbits, but not the size of the bodies concerned, being to scale. Before the conjunction of the three bodies (in the line Mars, earth, sun) is approached, Mars will first have the earth as a half-moon at a; this will gradually melt into a crescent till the moment of conjunction. Afterwards the crescent will broaden, and its diameter will be reduced till the point a' is reached, when the earth will appear as a half-moon again.

It is clear, therefore, that the earth will be a morning and evening star to Mars at the time of their nearest approach. The earth's crescent must not be too fine, or no observation will be possible on a dark background of sky. In other words, although we can observe Mars best when he is nearest, the privilege of seeing the earth when nearest to Mars is denied to his inhabitants.

We are now, then, in a position to discuss, so far as the mere conditions of visibility are concerned, the two suggestions as to earth-signalling to which I have already referred.

Mr. Galton's proposal depends upon the observation that a "reflected beam of sunlight sent through a hole in a plate in front of the mirror was just distinctly visible as a faint glint at a distance of ten miles when the hole was a square of one-tenth of an inch in the side." He then adds: "The amount of fog and haze that a beam of light would traverse between us and Mars when the planet was high above our horizon could not exceed that along a terrestrial base of ten miles; consequently the same proportion between the size of mirror and the distance would still hold true. It follows that the flash from many mirrors simultaneously, whose aggregate width was fifteen yards, and whose aggregate length (to allow for slope) was, say, twenty-five yards, would be visible in Mars if seen through a telescope such as that at the Lick Observatory. With funds and good will, there seems no insuperable difficulty in flashing from a very much larger surface than the above, and sending signals that the inhabitants of Mars, if they have eyes, wits, and fairly good telescopes, would speculate on and wish to answer. One, two, three, might be slowly flashed over and over again from us to them, and possibly in some years, to allow time for speculation in Mars to bear practical fruit, one, two, three, might come back in response. Dr. Whewell, if I recollect right, wrote a paper on the possibility of coming to an understanding with lunar inhabitants, if there were any. He would begin from the mathematical side. The practical difficulty is by no means insuperable of enabling many independent observers (who need not be near together) to direct their flashes aright. If mirrors could be mounted without much cost as heliostats (and perhaps they can be) it would be easy enough to do this. My own method is not practicable, at least without considerable addition and modifications, as it requires the object to be visible towards which the flash is directed, but Mars is not visible to the naked eye at day."[1]

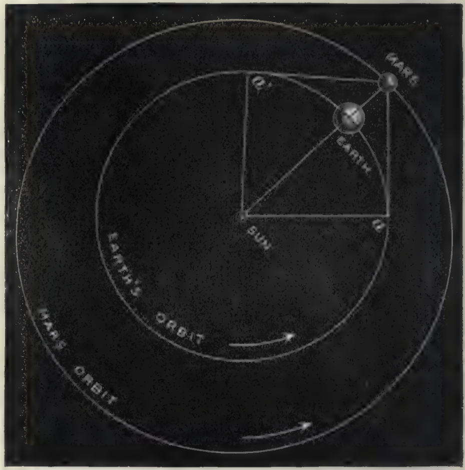

FIG. 2.—The Conditions of Visibility of the Earth from Mars.

Mr. Galton then uses sunlight and works in the day; Mr. Haweis, on the other hand, suggests electricity and night-time:—

"I infer from the astronomers that a signal on our earth about six miles in size of the nature of a bright light could be seen by the inhabitants of Mars, who by all accounts seem to be making the most systematic and herculean efforts to communicate with us by flashing triangular signals of presumably electric light. Why cannot we answer those signals by something which would resemble the lighthouse intermittent signal? Here is the method. London every night presents an area of at least twelve miles square brilliantly illuminated. That illuminating power might be enormously increased with only a few additional centres of powerful electric light. But without *any additional expense*, a little co-operation on the part of the gas companies would suffice to alternate darkness and light at intervals of five minutes over the whole of London between certain hours when traffic is more or less suspended. If only tried for an hour each night some results might be obtained. . . . . We have actually the mechanism for interplanetary communication every night—why not use it ?"[1]

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[1] *Times*, August 6, 1892.

Mr. Galton is careful to point out that his method of signalling requires sunlight, and that the signals are to be flashed to Mars in the Earth's daytime; the moment of opposition therefore is at once out of the question. Even with the Earth at either *a* or *a'* in our Fig. 2, the Sun and Mars would be 90° apart, and in any case the signals would be visible to the Martians (if visible at all) on the part of the earth lit up by the Sun. This does not seem a favourable condition, or at all events the most favourable one.

Mr. Haweis' plan secures a much stronger contrast. If it or something like it could be carried out, we can imagine the inhabitants of Mars studying the delicate earth crescent (with telescopes as powerful or more powerful than our own *bien entendu*), whether as a morning or evening star, and then seeing rhythmic flashes, reproducing the star included in the crescent of the Ottoman flag well within the horns of the crescent. Here we certainly get light on dark instead of light on light.

But there are other conditions of visibility besides those we have so far discussed. Supposing the whole electric energy of London turned on Mars would the volume of light be sufficient to produce a valid signal?

It is worth while, quite independently of the popular expectations of the present moment, to inquire into the actual conditions of the problem, telescopes on Mars as powerful as our own being always assumed.

If we are armed with a powerful telescope, under the best seeing conditions, first among which is its location at a considerable elevation, we may perhaps reckon upon using a power of 1000, that is, the object is magnified a thousand diameters; in other words, it is brought a thousand times nearer. In the case of the moon, under these conditions any part of her we might choose to study could be examined, as if from London we were viewing it over Yorkshire with the naked eye.

The late Mr. Lassell, I believe, claimed as the highest achievement possible with his 4-foot telescope in the pure air of Malta, that if the lunarians were shaking a carpet as large as Lincoln's Inn Fields he could see whether it was round or square. This then would be the *ne plus ultra* in the case of a body 240,000 miles away.

Now, if we take the nearest distance to Mars as 35,000,000 miles, as I have stated,

			Miles.	
1,000,000	magnifying power would give us the power of studying Mars as if it were		35	away from us.
100,000	ditto	ditto	350	
10,000	ditto	ditto	3500	
1000	ditto	ditto	35,000	

We can put this differently. To the naked eye at the distance of Mars $1'' = 160$ miles. Were Mars 1000 times nearer $1''$ would become ·16 mile. Now this at first seems very hopeful, for the exterior satellite of Mars has been seen in various telescopes.

We have already learned that the power employed last month at the Lick Observatory has not been so much as 1000, but such that the planet has been brought within a distance of 50,000 miles. Under these conditions a line on Mars a quarter of a mile long will subtend an angle of $1''$, or two lines a quarter of a mile apart should be separated and appear as doubles.

The second satellite to which reference has been made is only some 10 miles in diameter. We are justified by the visibility of the satellite, then, in saying that if a space 10 miles in diameter could be lighted up, as brilliantly as by sunlight, on the dark hemisphere of the Earth when Mars is above the horizon and at perihelion, it could be seen from Mars by telescopes equal to our own.

London, of course, is more than 10 miles in diameter, and we can imagine all the navies of the world with their search lights to flash simultaneously towards the planet, or to light up the clouds in a space as large as London, but there then will remain the question of the intensity of the light. What do electricians say is possible in this direction?

Whatever the answer to this question may be, it seems that signalling on Mr. Haweis' lines, light on dark, is a more hopeful proceeding than that suggested by Mr. Galton, and that on this system our conditions for reading signals are far better than those on Mars, as our dark hemisphere is much more exposed to our sister planet than is hers to us.

It is time now that we turn to those recent observations of our neighbour which have given rise to the ideas we have been discussing—ideas based upon the supposition that there is evidence which goes to show that the Martians are signalling to us by digging "canals" 1000 miles long and 200 miles wide, and then doubling them, and in addition lighting numerous signal fires or flashing electric lights!

Here we approach a region of astronomical inquiry which requires no enhancement of its interest by the intrusion of popular delusions or imaginings, which, moreover, for the next few months as details come to hand, will have all eyes directed to it.

It is not necessary to go further back than the year 1830 to appreciate the importance of the later inquiries. In 1830 Beer and Mädler made an admirable series of drawings of the planet which enabled them to affirm the existence of fixed markings, and having fixed markings, not a long series of observations was necessary to determine the period of the planet's rotation on its axis.

In 1862 I (and many others) had no difficulty in recognizing the features on the planet which Beer and Mädler had observed with smaller optical power thirty years before. The instrument employed was a 6-inch Cooke achromatic, which I still hold to be one of the finest telescopes ever made. It enabled me to add details to those before noted, and the observations left no doubt on my mind that Mars had an atmosphere like our own; that its temperature did not vary many degrees from our own; that there were land surfaces and water surfaces; clouds and very obvious cloud drift; polar snows which melted with marvellous rapidity as the perihelion sun made its full strength felt. Further, that the changes in the appearances observed, especially in the lighter or darker shading, depended upon clouds and the smoothness or roughness of the water surfaces.

This latter conclusion I arrived at from the fact that the darkest markings, assuming them to be water surfaces, were more or less land-locked, and that changes in some of these surfaces were always most obvious close to the land. It was clear also that the rapid melting of the polar snow must be accompanied by tremendous inundations.

I append, as an example of the kind of work done on the planet with the small refractors generally available thirty years ago, some extracts from a memoir I communicated to the Astronomical Society at that time.[1] The large refractors employed added so far as I know very little.

> "Although the complete fixity of the main features of the planet has been thus placed beyond all doubt, daily—nay, *hourly*—changes in the detail and in the tones of the different parts of the planet, both light and dark, occur. These changes are, I doubt not, caused by the transit of clouds over the different

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[1] *Pall Mall Gazette*, August 18.

[1] Mem. R.A.S. 1863, p. 179.

features. The effect of a cloudless and perfectly pure sky, both here and on Mars, appears to be that the dark portions of the planet become darkest and most distinctly visible; the coast-lines (if I may so call them) being at such times so hard and sharp, that (as has been mentioned by Mr. Lassell) it is quite impossible to represent the outlines faithfully; and this effect, be it observed, is completely distinct from the way in which the features grow upon one. MM. Beer and Mädler remark: 'Generally some time elapsed before the undefined mass of spots seen upon first looking into the telescope resolved itself into recognizable parts.' This observation will commend itself to all who have observed such a delicate object.

"The effect of clouds, on the contrary, will be, I think, to make the *dark portions less dark* in proportion to the density of the clouds, and the *light portions lighter* in the same proportion. *It can never make a light portion dark.* If this be so, when we see a dark spot well defined, we can be sure that no clouds are above it, and that we actually see the planet itself; we cannot be sure, however (unless we are acquainted with the locality from previous observation), that dark spots do not underlie any of the lighter portions. Some instances of cloud-transit were suspected by Father Secchi in 1858. Several unmistakable instances occurred during my observations. . . .

"But besides the cloud-masses, which, as we have seen, obliterate the dark portions either partly or wholly, giving rise to different contours and tones, and rendering the actual features of the planet undistinguishable, the dense atmosphere of Mars, with its fogs and mists, appears to go for very much. I mention this more especially to point out that—although its effect was evident in the southern hemisphere in mid-summer, upon the spots as they came on, and left the disc, as remarked by previous observers—it was much more evident in the northern hemisphere in mid-winter, blotting out, as before remarked, *even on the central meridian*, all features north of + 30° latitude. This would appear to furnish another proof of extreme seasons on Mars, in addition to that supplied by the rapid melting and great extent of the polar snows, and to point out the desirability of taking advantage of all oppositions which happen, as did those last year and in 1830, in the full summer-time of the southern hemisphere, when the atmospheric conditions of the planet may be considered the best possible. With regard to this last point, it may be remarked that the southern hemisphere is the one which we shall ever be able to study best, in consequence of the great distance of the planet from us at those oppositions which occur when the northern one is turned to us.

"With regard to the green and red tints so often noticed on Mars, my observations have led me to hold the same opinions as to their nature as those arrived at by Father Secchi in his study of the planet in 1858. Nor do I think that it can any longer be doubted that—as he considered probable—the green and red portions do actually represent seas and continents, and are not the effect of contrast.

"The dark portions were noticed to be decidedly green in my instrument, both by myself and others who observed Mars from time to time with me, the colour being especially marked in Beer and Mädler's spot *p n* (Drawings Nos. 7 and 8). In spite of the over-correction of my object-glass, which should have 'reinforced' the red tinge, it was never sufficiently decided, I think, to suggest a contrast; and, indeed, the green was sometimes unmistakable when the red was not noticed, and when therefore there was no contrast to mislead the eye.

"Another point of agreement between the two series of drawings is not a little remarkable: the spots which were observed to be of a most decidedly dark tint in 1830 were darkest last year; and supposing the dark portions to be water, the darkest spots are those which are nearly, if not quite, land-locked. Passing on from the consideration of the general features of the planet, the snow-zone next demands our attention. . . . . Last year the solstice occurred on August 30, on the 23rd of which month the snow-zone was estimated to be $\frac{1}{6}$ of the apparent diameter; by the 25th of the next month, September, this was reduced to about $\frac{1}{10}$, and again to $\frac{1}{13}$ by October 11, when it was at times scarcely discernible; after which it began apparently to increase again.

"To the great eccentricity of the orbit of Mars, and the fact that the summer of the southern hemisphere occurs when the planet is near perihelion, is doubtless to be ascribed this very rapid melting of the southern snow-zone, an observation confirmed by the much slighter variation in the dimensions of the opposite one. It appears to follow from my drawings, and I think also from those of Messrs. Beer and Mädler, although they make no mention of the fact, that even at its minimum the centre of the snow-zone was not absolutely coincident with the planet's pole, being situated in somewhere about 20° of areocentric longitude (using Beer and Mädler's start-point), and in a latitude probably only a very few degrees from it. . . . . The snow-zone was at times so bright that, like the crescent of the young moon, it appeared to project beyond the planet's limb. This effect of irradiation was frequently visible; on one occasion the snow-spot was observed to shine like a nebulous star when the planet itself was obscured by clouds, a phenomenon noticed by Messrs. Beer and Mädler, recorded in their valuable work, *Fragments sur les Corps Célestes.* The brightness, however, seemed to vary very considerably, and at times, especially when the snow-zone was near its minimum, it was by no means the prominent object it generally is upon the planet's disc."

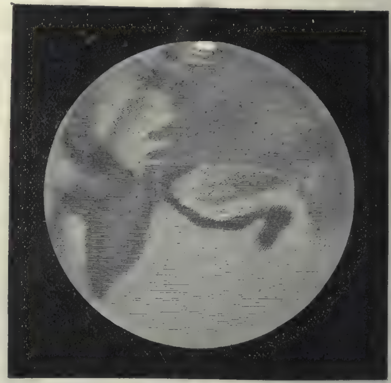

FIG. 3. Mars September 25, 1863, showing the darker shading of a land-locked water surface and its projection into the open water beyond.

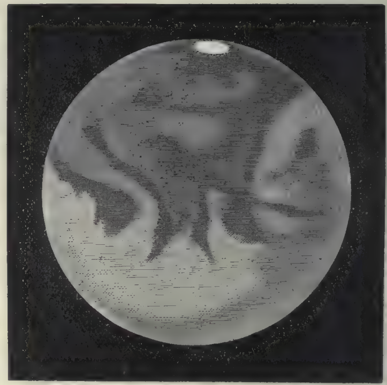

FIG. 4. Mars September 23, 1862, showing bright appearance of snow cap, and the details of one of the chief coast lines.

We owe it to the illustrious Italian astronomer Schiaparelli that a world of wonders undreamt of thirty years ago now forms the chief subject of inquiry. His work was begun at the opposition of 1877, which, as we have seen, was as favourable as the present one, and continued during that of 1879-80. He showed that those parts of the planet which had been regarded by myself and others as the land surfaces, instead of being wanting in detail, as they had been seen, were really riddled by streaks, many of them very long and very straight, but in every case running towards a water surface, and in many cases connecting two water surfaces. These streaks he called *canali*, which in Italian, as *canalis* in Latin, means either a channel, a canal, or a pipe. Unfortunately, however, whenever it has been translated into English the word *canal* has been used, which of course with us suggests human labour. We have already seen what this has led to.

As a result of this minute inquiry rendered possible by his fine instrument (8¾ in. Merz) and perfect observing weather, a complete map of the planet with these channels was made.[1] But this was but the beginning of marvels. During the opposition of 1881-82 the work was continued, and now Schiaparelli, besides endorsing all the discoveries of 1880-81, found that in at least twenty cases the channels were doubled and consisted of two streaks 200 or 400 miles apart, instead of one. I append a copy of the sketch map he gave in his preliminary communication to the Academy of the Lincei.[2]

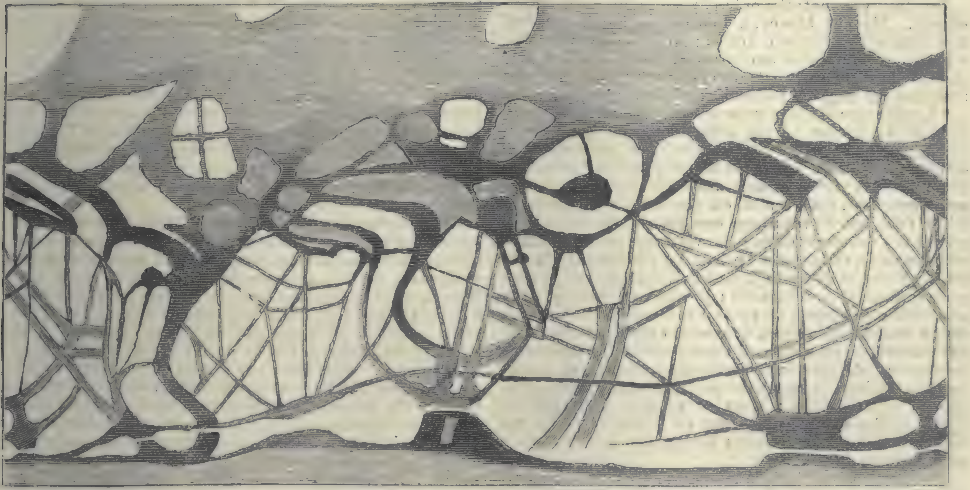

FIG. 5. Doubling of the channels, observed by Schiaparelli in 1882.

He distinctly stated that the doubling of these channels seemed to be connected with the time of the planet's year, and to occur simultaneously over the superficies of the planet which is supposed to represent land. When the opposition took place in August, that is in the full winter of the northern hemisphere, no trace of the doubling was visible which is precisely what we should expect if the doubling depended in any way upon inundations caused by the melting of the northern snows, the north pole being turned away from the sun. The vernal equinox took place on December 18, 1881, and the opposition took place in the same month. The doubling of 17 of these channels was observed between January 19 and February 19—that is, in the late spring of the northern hemisphere, which again is precisely what we should expect if they were connected with inundations.

Not only was this wonderful change noted, but here and there bright spots (previously noted by Green in 1877, and recalling Dawes' "snow island," seen in 1865), were recorded.

In the doubling of these water channels then, and in these snow-tipped hills, we have the origin of the "canal digging" and "fire signals" of which we have lately heard so much.

It will thus be seen that the widespread notions of the signals from Mars rest only on a mistranslation and upon the popular imagination running riot among the startling revelations of modern observers, among whom in this special line of work Schiaparelli must be acknowledged as *facile princeps*.

The observations which engendered invention in one class of minds engendered doubts in others, but the work of Perrotin and Thollon at Nice in 1886 with the 15-inch refractor has completely endorsed the main points advanced by Schiaparelli with regard to the existence of the channels or straits. Two or three references to their published papers will show clearly what their view of the relation of them to the variously-tinted parts of the planet really is:—

"The triangular continent, somewhat larger than France (the Lybia of Schiaparelli's map), which at that time stretched along both sides of the equator, and which was bounded south and west by a sea, north and east by channels, has disappeared. The place where it stood, as indicated by the reddish-white tint of land, now shows the black, or rather deep-blue, colour of the seas of Mars. The Lake Mœris, situated on one of the channels, has also vanished, and a new channel, about 20° long and 1° or 1°·5 broad, is now visible, running parallel with the equator to the north of the vanished continent. This channel forms a direct continuation of a previously existing double channel, which it now connects with the sea. Another change is the unexpected appearance about the north pole of another passage, which seems to connect two neighbouring seas through the polar ice."[1]

A short time afterwards M. Perrotin stated that this same district of Libya, had undergone a further change, the "sea" which had so recently covered it having retreated again for the most part, so that the appearance of the district was intermediate between that which it recently presented and that under which it was seen in 1886. Of the channels M. Perrotin has noticed four, three of which are double, which, starting from the "seas" of the southern hemisphere near the equator, and following a nearly meridional course, extend right up to the north polar ice cap, being traceable across the "seas" which immediately surround the latter.

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[1] Osservationi astronomiche e fisiche sull' asse di rotationie e sulla topografia del pianeta Marte. R. Accad. dei Lincei, 1880 81

[2] Memorie della Soc. Spettroscopisti Italiani, vol. ix. Dis. 6, p. 25.

[1] Abstract in NATURE May 21, 1888.

Although Schiaparelli, as it will have been seen, connects the changes in the channels with the seasons of Mars, and although Perrotin and Thollon show their relation to the seas in their vicinity, other explanations of the phenomena have been suggested. Among these we must first refer to the view of Fizeau,[1] that we were in presence of the results of glaciation on a tremendous scale, the parallel ridges being likened to crevasses or rectilinear fissures! It was imagined by him that relatively longer seasons and a lower temperature were capable of producing crevasses some thousands of miles long and hundreds broad.

But this was not the only physiographic explanation offered. Mayeul Lamey, a Benedictine monk, ascribed the channels to volcanic action; to him they were the remains of enormous crater walls, and he states that they are best seen when Mars reaches its most gibbous form and the angle of the incident light is greatest.

"Le plus souvent les astronomes se bornent à observer Mars vers l'époque de son opposition, c'est-à-dire de sa plus grande proximité de la terre; c'est, pensent-ils, le meilleur moyen de voir bien et de près les 'mers' de Mars. Si ces taches étaient des mers la raisonnement serait excellent, mais il n'en est pas ainsi. M. Schiaparelli a déjà fait la remarque que les canaux découverts par lui ont été observés non au voisinage de l'opposition mais un mois, deux mois après. Et pourtant la planète est alors bien eloignée déjà de nous. Pour moi, je constate également le même fait; je découvre tous les soirs un nombre de cirques de plus en plus considérable. La raison en est bien simple, du moment que les taches sont des ombres, ou du moins des parties réfléchissant moins lu lumière. A l'époque de l'opposition, en effet, les rayons solaires tombent à peu près perpendiculairement sur la surface de la planète; Mars ne possède alors pas de phase, tandis qu'un mois avant ou après, la phase est très accentuée et les ombres deviennent possibles avec les élévations du sol."[2]

Another attempted explanation was that the channels were doubled in consequence of some play of diffraction. But enough has been said on this head; let us rather turn to the first fruits of last month's work.

At the Lick Observatory the channels were seen, and one of them was considered by three observers to be doubled.

From Peru we learn that Prof. Pickering saw many of the channels observed by Schiaparelli, but all were found to be single. The telegram adds, "not double, as stated by him"; but here is an error. We are near the southern solstice, as in 1877, and they were *not* seen double at that epoch. But even this is comparatively uninteresting after the revelations as to the effects of the melting snows.

Prof. Pickering discovered two mountain ranges in Mars to the north of the green patch near the planet's south pole. Between these mountain ranges the melted snow has collected before flowing northward. In the equatorial mountain regions snow fell, covering two of the summits, on August 5. On August 7 the snow had melted. "I have seen eleven lakes," the professor writes, "varying in size. These lakes branched out in dark lines connecting them with two large dark areas like seas, but not blue. There has been much local disturbance in the clouds round the planet since the snow melted, as is evident from the dense clouds which were concentrated within one area. These clouds were not white, but yellowish in colour, and partly transparent. They now seem to be breaking up, but are still hanging densely on the south side of the mountain range. The northern green spot has been photographed."

Surely we have here the connection between the work of 1862 and 1877. The channels are true water channels; at one time at low channel we may have an unimportant stream like the low Nile; at another an ancient river-bed as it were, is filled to the utmost limit by the inundation. One requires to have seen an Indian river, or better still, the Nile valley to realize what an inundation may mean, and especially under the conditions which have now been established to exist on Mars. But we may go further. A comparison of Schiaparelli's sketch of 1882 with his map of 1879, helps us considerably, and shows that we must take the effect of clouds over warm water into consideration. Two among the most undoubted and continuous water-surfaces which I observed in 1862, which he has named Mare Cimmerium and Sabæus Sinus, were doubled also in 1882, and in my mind there is no doubt whatever that this doubling, at all events, is due to cloud banks lying, or rather travelling longitudinally, along the centre of the water-surface, precisely as the most magnificent cumuli which I have seen on this planet, follow the Equatorial current, entering the Carribean Sea by Tobago. Obviously, by their lightness of shade, the channels are shallow, and they are only noticed in or near the tropics, so that the water must be highly heated before it empties itself into any of the southern seas.

Certainly it must be acknowledged that while the revelations show a remarkable similarity to our own atmosphere, so far as chemical structure and temperature are concerned, for the *onus probandi* lies with those who deny that we are dealing with the various forms of water, it would appear that the extremes of heat and cold are more generally operative in Mars than with us. The problem thus presented to us should prove interesting to the geologist. Was there any period in the earth's past history, or can there be in the future, which more resembles the present Martian conditions? Had we these enormous inundations, chiefly caused by polar snows melting? If not, were we sheltered from them by our more circular orbit and shorter year? Is Mars red because it is muddy? If so, what mud could give it the tinge we know?

J. NORMAN LOCKYER.

NOTES.

FOR some days much anxiety was felt as to the condition of Sir Richard Owen. We are glad to say that his health has greatly improved, and that he is now able to take more nourishment.

THE four hundredth anniversary of the discovery of America is being celebrated this week with great splendour at Genoa. The King and Queen of Italy are taking part in the celebration, and the maritime Powers are represented by a fine assemblage of warships.

A BOTANICAL CONGRESS, which is attended by some of the most eminent botanists of Berlin, Paris, Jena, and St. Petersburg, was opened at the University of Genoa on September 5.

AN interesting ceremony took place at the University of Genoa on Tuesday, when the Hanbury Institute was formally handed over to that body. The correspondent of the *Times* at Genoa says that Mr. Thomas Hanbury, an English gentleman, whose house at La Martola, near Ventimiglia, is well known to visitors to the Riviera, had already won the gratitude of Italians by his generous deeds in that neighbourhood, and a year or two ago he offered £4000 to found an institution in Genoa for the encouragement of the study of botany. Senator Secondi, president of the University, gave expression to a sincere feeling of gratitude towards Mr. Hanbury, and accepted the gift of the institute in the name of the University. A large number of distinguished botanists, who are attending the congress now being held there, were present at the ceremony.

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[1] *Comptes Rendus*, June, 1888.

[2] "Note sur la Découverte du Système Géologique Éruptif de la planète Mars." Par Fr. Mayeul Lamay, O.S.B. Autun. (Dejussien, 1884.)

THE meeting of the German Mathematicians' Union in Nürnberg, and the Mathematical Exhibition, are postponed on account of the cholera.

THE German Chemical Society have resolved to found an Institute in remembrance of the late Prof. von Hofmann. Large funds will naturally be required, and all pupils and those who honour Hofmann's life and work are earnestly requested, in a recently-issued circular, to send contributions. Even those who had no personal knowledge of the illustrious *savant*, but have been inspired to work by his example, will no doubt be willing to take part in the scheme. The proposed Institute will not merely serve chemical purposes, but will be a place of general scientific research.

THE International Congress of Physiologists has held its second triennial session at Liège with Prof. Holmgren (Upsala) as President, in the Physiological Institute under Prof. Léon Fredericq. The Congress terminated on Thursday, September 1, after a banquet at which the Burgomaster of the city was present. More than one hundred physiologists attended the Congress.

THE thirteenth Congress of the Sanitary Institute will be held at Portsmouth from September 12 to 17. Sir Charles Cameron will preside. The Congress will be divided into three sections—one dealing with sanitary science and preventive medicine, another with engineering and architecture, and a third with chemistry, meteorology, and geology. Conferences will be held by naval and military hygienists, by medical officers of health, by municipal and county engineers and surveyors, by sanitary inspectors, and by ladies on domestic hygiene. A health exhibition, including sanitary apparatus and appliances, in connection with the Congress, will be held in the Drill Hall from September 12 to October 8.

A PHOTOGRAPH of the late Admiral Mouchez—one of the best photographs of him we have seen—appears in the July number of the *Bulletin Astronomique*, which journal owes its existence to his indefatigable exertions. There is also a brief account of his life written by M. Tisserand.

THE sixth session of the Vacation Courses, known as the Edinburgh Summer Meeting, has just come to a close after a very successful month's work. The importance of this meeting increases year by year with the steadily increasing number of students, and with the more complete organization of the plan of study. This has again been arranged so as to assist in the training of school teachers and University Extension lecturers for the new duties which are beginning to devolve upon them in connection with the requirements of County Councils for technical education. Hence the principle of "Regional Study" has again been kept prominently in view, Edinburgh and its districts being taken as a typical area, and affording a starting point and vivid concrete illustrations for the courses on sociology and anthropology (Profs. Geddes and Haddon) on the one hand, and on the other for those on biology (with special courses of zoology and botany) and physiology by Mr. J. Arthur Thomson, Prof. Haycraft, and others. The course on literature by Prof. Moulton, which was very largely attended, followed to a large extent the same general lines as the more purely scientific courses. The work in the historical seminary and the studio was continued, and a series of technical education lectures was given in the evenings by Principal Dyer, Profs. Mavor, Geddes, and Prince, Mr. C. Williams, and others. Many nationalities were represented among both students and teachers. Besides many British Association and other visitors, Profs. Haeckel (Jena), Delage (Paris), attended the meeting. Special lectures were delivered by Profs. Devine and Rolf (Philadelphia), Profs. Manouvrier and Demoulins (Paris), Principal Dyer, Profs. Mavor, Prince, Lloyd Morgan, Sollas, Messrs. R. Aitken, W. Renton, R. Irvine, and others. A series of interpretative recitals by Prof. Moulton, and four concerts illustrating the history of music were also given.

FIFTY scholarships, named the Townshend Scholarships, from funds bequeathed by the late Rev. Chauncey Hare Townshend, for working-class boys or girls between 14 and 21, to be held for one year, have just been established in connection with the Westminster Technical Institute, 40 being free and 10 competitive. The subjects taught in the Institute, which was founded by the Baroness Burdett-Coutts, are rudimentary, commercial, and technical, and include drawing, technical, mechanical, and artistic; geometry, practical, plane, and solid; working in wood, lead, metal-plate, &c.; cookery, dressmaking, shorthand, foreign languages, &c.

A REMARKABLE grotto, which is exciting the interest of French geologists and mining engineers, was recently revealed by an explosion during the progress of the ordinary work in a quarry at Taverny. The Paris correspondent of the *Times* says there is a subterranean gallery, with walls polished as if by water; and that it is some 1500 feet in length, and ends in a great chamber about 40 feet in diameter and 6 feet in height. Scientific men have hazarded various conjectures as to the source of the watercourse by which this cavity seems to have been formed.

MR. HERMANN KRONE gives, in No. 7 of Wiedemann's "Annalen," an account of some further experiments connected with the photography of spectra in their natural colours by Lippmann's method. He finds that the correct rendering of the various colours depends upon a high degree of accuracy in the proportions of the finely divided silver haloid and the colour sensitiser, as also upon the temperature of drying, the exposure, and the development. If the essential conditions are not fulfilled, it may happen that yellow appears in the place of red, or that green exhibits a direct transition into violet, the blue being unrepresented. The result also depends upon the amount of water contained in the film, as influencing its thickness, and in the case of the solar spectrum upon the altitude of the sun. With a very long exposure the infra-red appears as a dark purple, and the ultra-violet as a yellowish-pink lavender colour. Mr. Krone has also succeeded in producing coloured photographs without Lippmann's mercury mirror. He simply covers the film with black velvet, exposing, as Lippmann did, through the glass. In this case, the reflection from the inner surfaces of the glass takes the place of that from the mercury. The exposure has to be considerably prolonged, and the colours towards the red end are less pure; but the blue, violet, and ultra-violet are quite as brilliant and well defined as in the mercury process.

DURING the past week the weather has assumed a decidedly autumnal character, the maximum temperatures being below 65° in many parts of the United Kingdom, and below 55° in some of the northern parts. For the first few days depressions from the Atlantic caused unsettled and showery weather, with strong winds or gales. On Sunday, however, an area of high pressure spread over England, and under its influence the sky rapidly cleared, and the wind became northerly, while at Greenwich Observatory a temperature of 4° below freezing point was registered on the grass; but the more northern and western parts of the Kingdom were still disturbed by depressions from the westward. These have subsequently spread over the greater part of the country, and winds have again become south-westerly generally. The facts shown by the *Weekly Weather Report* for the period ending the 3rd instant, are interesting:—The rainfall exceeded the mean in all districts, the greatest excess being in the west of Scotland and the north-west of England, and the fall was more than twice as much as the normal amount over the Kingdom generally. Temperature was below the mean in all districts, except the south of England and the Channel Islands, while in Scotland the lowest shade minima were between 32° and 35°.

PROF. MOHOROVIÉIÉ, of Agram, writes to the *Meteorologische Zeitschrift* for August a preliminary notice of a most destructive wind-rush, which occurred at Novska, in Slavonia, on May 31 last, and which he has been requested by the government to investigate on the spot. He reports that as the train left Novska station soon after 4 p.m. on that day, a sudden darkness came on; all the carriages of the train were thrown off the line with a great crash, and three of them were carried by the force of the wind to a distance of about 100 feet, the violence of the wind being aided by the bursting of two water-spouts over the railway. The tornado then traversed a primeval forest which lies to the north-east of Novska, tearing up over 150,000 large trees, and stretching them on the ground round the centre of the disturbance with the regularity of arrows around a barometric minimum of a weather chart, in a lane of about 1½ to 2 miles in diameter. Among the curious instances is one of a girl, seventeen years old, being carried unhurt for a distance of over 300 feet. Were it not for the trustworthy source whence this information is obtained we should consider it to be greatly exaggerated, but Prof. Mohoroviéié states he crossed the forest three times and carefully noted the position of the fallen trees, and he will no doubt give an official report of the occurrence later on, accompanied by meteorological data from various stations.

IN vol. xiv. of *Aus dem Archiv der Deutschen Seewarte* there is a discussion by E. Herrmann on the storms of the German coast in the years 1878–1887, based upon an examination of the observations taken at forty-seven stations, and containing monthly and yearly charts showing the prevalence of the winds from the various points of the compass. The results show a great preponderance of storms in the Baltic as compared with the North Sea; in ten years 191 storms are recorded in the Baltic and 101 in the North Sea. The decrease of storms in the North Sea in summer is also much more marked than in the Baltic. The maximum of westerly storms occurs in December, and that of the easterly storms in March and April. In the summer months most storms occur in August. The change of direction of the storms from south-west to north-west occurs most frequently in February, March, October, and November; and from north-west to south-west in January, February, and October.

IN a recent valuable memoir to the Berlin Academy on Thermodynamics of the Atmosphere (fourth of a series), Prof. von Bezold considers the cases of supersaturation with vapour, and of "overcooling" (regarding the latter it may be stated that clouds have been observed at a temperature below freezing, but having no ice-particles,—purely water clouds). A sudden cessation of these states, he shows, must result in rapid rise of air-pressure, which is generally of short duration, unless conditions are present which prevent its descent again. As such variations of pressure are characteristic of thunderstorms, the author goes on to investigate the *rôle* of supersaturation and overcoolings in these phenomena, and he shows how various movements and changes in form of thunderclouds, and the origin of hail and other phenomena, may be explained by them. He is of opinion that much thunderstorm rain has, high up, the form of hail or sleet, and the large drops are simply melted hail or sleet particles, these forms playing a more important part in thunderstorms than is commonly supposed.

A REUTER'S telegram from Catania, dated September 2, announced that the eruption of Etna had broken out afresh, and that the chestnut woods on the mountain slopes were being devastated by the lava, which was pouring down the mountain in one dense mass, instead of flowing in two separate streams, as it did before.

THE Norfolk and Norwich Naturalists' Society has issued its Transactions for 1891-92. We are glad to see that this Society, which has now entered upon its 24th year, continues to prosper, the roll of members numbering 250, and the balance-sheet being very satisfactory. The catalogue of the library, which is printed in the current number of the Transactions, occupies 43 pages. Dr. Wheeler, in his presidential address, discourses on the changes which have taken place in recent times in the distribution of some species of insects, more especially of the typical insect fauna of the old fen-land of Huntingdonshire and Cambridgeshire and of the Norfolk Broads. Dr. Plowright contributes a paper on "Neolithic Man in West Norfolk," with illustrations, by Mr. Worthington Smith, of a number of flint implements found on Massingham Heath, near Lynn, and a description of the site of an ancient British village in the same locality. This is followed by a paper on the St. Helen's Swan Pit, in Norwich, where, towards the end of August, from 80 to 100 cygnets may yearly be found gathered together for the purpose of being fatted for the table. Mr. Southwell, the writer of the paper, also gives some interesting particulars of the breeding of the Mute Swans, which abound on the Norfolk waters. Mr. Clement Reid follows with a paper "On the Natural History of Isolated Ponds," as illustrating the dispersal of the fauna and flora of a district in recent times; and Mr. O. V. Aplin contributes a paper "On the Distribution in Great Britain and Ireland of the Red-backed Shrike." This is followed by the eleventh annual report on the Herring Fishery of Yarmouth and Lowestoft, by which it appears that the enormous number of 290,650,800 of these fish were landed at those ports in 1891. There are other minor papers "On the Meteorological Features of 1891," by Mr. Preston, and shorter notes on the "Marine Fishes of Yarmouth," the "Botanical Occurrences of the Past Year," and other matters of interest.

ACCORDING to a report compiled by the French Statistical Bureau, the vineyards of Europe cover 22,973,902 acres. Italy comes first with 8,575,000 acres, followed by France with 4,592,500, Spain with 4,012,500, Austria and Hungary with 1,637,500, and Germany with 300,000 acres. The annual average production of the European vineyards is put at 2,652,300,000 gallons; Italy producing (in round figures) 697,000,000 gallons, France and Spain 608,000,000 each, Austria-Hungary 208,000,000, and Germany 51,000,000 gallons. Spain exports most wine (200,000,000 gallons), but it is chiefly common wine, and it is estimated at only £12,000,000, while the value of the 56,000,000 gallons exported from France is put at nearly as much. Italy comes third with exports of 45,000,000 gallons, estimated at £2,800,000, while Austria and Hungary exported only 16,500,000 gallons worth £1,720,000.

THE American journal *Electricity* notes that Prof. Elisha Gray, Chairman of the World's Congress Committee on an Electrical Congress, has returned to America from Europe. He visited England, France, Germany, Austria, Roumania, Turkey, Italy, Greece, and found everywhere that a lively interest was taken in the Columbian Exhibition. In an interview in the daily press he says, "Many eminent electricians of different countries are expected to attend the congress, including a large number from Great Britain. The work of the World's Congress auxiliary has been done so quietly that the general public is not aware of its extent and efficiency. There seems now to be no question that the World's Congress of 1893 will be very much more largely attended and will be conducted on a more imposing scale than those of any previous occasion in the world's history."

A MODEL of ocean currents is to be shown at the Chicago Exhibition. The surface of the earth is represented on "a huge scientific tank" by an area of about 30 feet square, the ocean and seas being shown by actual water. Small streams of water are ejected through pipes under the model so that the whole body of water moves exactly as the ocean currents move. The direction of the currents is shown distinctly by a white powder on the surface of the water. Near the model will be placed a large map giving details as to the force, volume, and direction of the various ocean currents.

A USEFUL catalogue of Michigan plants, prepared for the thirteenth annual report of the Secretary of the Michigan Board of Agriculture, has been issued separately. It has been drawn up by W. J. Beal and C. F. Wheeler. It is based on a "Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Michigan, Indigenous, Naturalized, and Adventive," by C. F. Wheeler and E. F. Smith. The compilers hope that the publication of their list will stimulate local observers and collectors to do what they can to add to what is known about the plants of Michigan, especially in the matter of geographical distribution.

DR. R. W. SHUFELDT contributes to the Proceedings of the U.S. National Museum (vol. xv., pp. 29–31) a short but interesting paper on "A Maid of Wolpai"—a girl of about fifteen years of age, belonging to the pueblo of Wolpai in north-western Arizona. A portrait of her accompanies the paper. The writer's object is not so much to talk about this particular girl, as to describe the life of a Wolpai woman at the various stages of her career. His conclusion is that, upon the whole, it is by no means an unhappy life. "From her babyhood to maturity," he says, "it is filled in with many pleasurable chapters, and no doubt a great deal of this is due to their contented dispositions, their love of home, and their untiring industry."

IN another paper contributed to the same volume (pp. 279–282) Dr. Shufeldt discusses the evolution of house building among the Navajo Indians. From November, 1884, to the early spring of 1889 Dr. Shufeldt lived at Fort Wingate, a military station in north-western New Mexico, and during the early part of this period there was always to be found a floating population of Navajos living on the outskirts of the fort. He had thus many opportunities of studying their various arts and industries. He shows that contact with the civilization of the white man has led these Indians to improve their plans of house building, and has had "the effect of bringing about an evolution of the same."

A VERY original mode of treatment of some nervous complaints has been recently developed by Dr. Charcot, at the Salpêtrière, in Paris (*La Nature*). He was led to it by observing that patients afflicted with *paralysis agitans*, or shaking palsy, often seemed greatly relieved after long journeys by rail or carriage. The greater the train speed and oscillation, the rougher the road and the shaking, the more they liked it and were benefited. Dr. Charcot, taking up the idea, had a chair made, to which a rapid movement from side to side was imparted by electrical agency; like what one sees in processes of sifting by machinery. To a healthy person the experience is execrable; he very soon seeks relief. Not so the patient, however; he enjoys the shaking, and after a quarter of an hour of it, is another man. He stretches his limbs, loses fatigue, and enjoys a good night's sleep afterwards. There are various other nervous diseases to which the method applies. Certain physicians, indeed, have before used such things as tuning-forks and vibrating rods in treatment of neuralgia, &c. A student of Dr. Charcot, Dr. Gilles de la Tourette, has had a vibrating helmet constructed for nervous headaches. It is applied to the head by means of a number of steel strips. Above is a small electric motor making 600 turns a minute; and at each turn a uniform vibration is imparted to the metallic strips, and so to the head. The sensation is not unpleasant; it induces lassitude and sleepiness.

ON Friday last Prof. R. L. Gardner, of Virginia, addressed the Balloon Society of Great Britain on his researches relating to what he calls the speech of monkeys. He defined speech as that form of materialized thought which was restricted to such sounds as were designed to convey a definite idea from mind to mind. It was, therefore, only one mode of expressing thought; and to come within the limits of speech the sounds must be voluntary, have fixed values, and be intended to suggest to another mind a certain idea or group of ideas more or less complete. Not only did these marks characterize the sounds of monkeys as speech, but, in addition, the sounds were always addressed to certain individuals, with the evident purpose of being understood. Monkeys usually looked at the individual addressed and did not utter these sounds when alone or as a mere pastime. They understood and acted in accordance with the sounds when imitated by the phonograph or other mechanical means, and this indicated that they were guided by sounds alone, and not by signs, gestures, or a physical influence. He had also discovered that some monkeys could count three and had favourite colours, but he did not think they had names for them. He had for hours together watched monkeys convey to each other by sound the apprehension of danger and other emotions. His task, which was not easy, was to perpetuate or imitate these sounds. In some cases he was successful, but to no great extent. At last he turned to the phonograph—an instrument which was practically unknown in this country, save as a clumsy toy. But a properly manipulated phonograph could repeat sounds, previously recorded, with mathematical precision. He had the good fortune to find that the sounds so carefully preserved in one zoological garden provoked interest, and were apparently quite intelligible to monkeys in other gardens in distant countries. His observations had hitherto been conducted with monkeys in captivity, but he was now on his way to the deep forests of Western Africa, once visited by Paul du Chaillu, in order to study the language and habits of the great apes. He was carrying with him an outfit of the most complete and unique character that had ever been brought into use for such purposes. He meant to live in a cage and to provide himself with an electrical apparatus. His cage was convertible, and weighed 320lb., and he could make four cages of it and bring home a gorilla in one of them.

AT the last prize contest instituted by the City of Paris for the best electric meter the prize of 5000 francs was awarded to Prof. Elihu Thomson. Desiring that this sum should serve for the development of the theoretical knowledge of electricity, Prof. Thomson requested M. Ernst Thurnauer, General Manager for Europe of the Thomson-Houston International Electric Company, to offer a prize for the best work on a theoretica question in electricity, and to organize a committee who should propose the subjects, examine the productions, and decide the prize. The following gentlemen have consented to act as members of the Committee:—J. Carpentier, President of the Société Internationale des Electriciens; Hippolyte Fontaine; E. Hospitalier, Professor in the School of Physics and Chemistry of the City of Paris; E. Mascart, Member of the Institute; A. Potier, Member of the Institute (Examiner); B. Abdank-Abakanowicz, Consulting Engineer (Secretary of the Committee). The Committee has decided that the prize should be given for an investigation on one of the following subjects:—(1) The heat developed by successive charges and discharges of condensers under different conditions of frequency, nature of dielectric, and quantity of charge. (2) It has been shown theoretically that when the two surfaces of a condenser are connected by a conducting body, the condenser becomes the source of alternating currents as soon as the resistance of the conducting body decreases below a certain limit. The formula that permits calculating the period of this oscillation has not yet been completely verified. This period of oscillation should be investigated experimentally under conditions such that the exact measure of resistance, capacity, and coefficients of self-induction may be possible, in order to arrive at a complete and precise verification of this formula. (3) When a condenser made with an imperfect insulating material has been charged and then left to itself, the charge is gradually dissipated. The time necessary for the charge to be reduced to a given fraction of its initial value depends only on the nature of the insulating material. It is proposed to investigate whether, as certain recent theories would seem to indicate, analogous phenomena do not present themselves in metallic conductors, and whether these can be shown experimentally. (4) It is proposed to arrange and systematize our present knowledge of the graphical solutions of electrical problems, and deduce from them some general methods as in graphical statics. The theses presented may be written in any one of the following languages:—English, French, German, Italian, Spanish, or Latin. They may be in manuscript or printed. Each thesis presented must be signed by a pseudonym and accompanied by a sealed envelope bearing the same pseudonym on the outside, and with the name and address of the author inside. The papers must be sent before September 15, 1893, to B. Abdank-Abakanowicz, Consulting Engineer, the Secretary of the Committee, at 7 Rue du Louvre, Paris, who will furnish any further information required.

THE additions to the Zoological Society's Gardens during the past week include a Black-handed Spider Monkey (*Ateles geoffroyi*) from Nicaragua, presented by Mr. F. Vyner; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. Gerald E. Bridge; a Black-shouldered Kite (*Elanus cæruleus*) captured at sea, presented by Mr. J. Watson; a Falcated Teal (*Querquedula falcata* ♂) from China, presented by Mr. A. C. Moule; an American Black Snake (*Coluber guttata*) from North America, deposited; two Mule Deer (*Cariacus macrotis* ♀ ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE STAFF AT THE LICK OBSERVATORY.—We are sorry to notice the very considerable changes that are now taking place in the staff at the Lick Observatory. It seems only quite recently that Prof. Keeler tendered his resignation to take over the directorship of the Allegheny Observatory, but now we hear that Mr. Burnham has resigned, and that Prof. Henry Crew has done the same, the former having accepted a position of clerk in one of the courts of Chicago, and the latter having been elected to a Professorship of Physics in the North-Western University at Evanstown, Ill. With the loss of these men the observatory will be crippled for some time; for, although very good men will be found to take their places, a thorough acquaintance with the instruments can be obtained only by constant and frequent practice. Of the remainder of the staff Mr. Barnard and Mr. Schaeberle will be the only representatives of the older members. What the cause of these changes is we do not know, but there seem to be signs of a little friction somewhere, for what is the probability that three men should sever their connection with such an observatory in the space of a year—assuming, of course, normal conditions?

THE OBSERVATIONS OF KLINKERFUES REDUCED.—The second part of the *Astronomische Mittheilungen of the Royal Observatory* in Göttingen contains a complete reduction of Klinkerfues' observations which he made in the years 1858 to 1863. The work has been undertaken by the Director of the Göttingen Observatory, Prof. Wilhelm Schur, and has been printed at the expense of the König. Gesellschaft der Wissenschaften zu Göttingen. In the introduction Prof. Schur gives a complete account of the instruments used and the methods by which the observations were made. The zone included in this work is that which lies between + 15° and − 15° declination. The interest that is attached especially to these observations is caused by the fact that Klinkerfues did not wish to adopt the usual method for determining the declinations directly from the readings of the vertical circles, but he used that generally known as Gauss' method, in which a mirror and scale played an important part. The epoch to which all the places are referred is that of 1860, and a table is also added by which the yearly precession in right ascension and declination can be easily determined.

PHOTOGRAPHS OF SOLAR PHENOMENA.—To the August number of *Astronomy and Astro-Physics* are contributed some striking pictures that represent some of the latest advances made by the application of the photographic plate to the telescope. These photographs were taken by Prof. G. E. Hale, of the Kenwood Astro-Physical Observatory, with the new spectroheliograph, a description of which instrument will be found in the May number of the same Journal. The first photograph displays the spots and faculæ on the solar surface on May 21 last: a single glance at it will show us that we shall have to change very considerably our present ideas as to their extent, for instead of equalling the spots in area they exceed them so much as to place them relatively in entire insignificance. Another point that is at first noticed from the same photograph is the paucity of the faculæ at the limb with respect to the more central part of the disc, but this is, as we are told, only a fault in the process of reproduction, for in the original negatives the faculæ "are equally well shown on all parts of the solar surface." Another photograph of interest is that of the chromosphere and prominences taken on the same day; this was obtained by cutting off the light issuing from the solar disc by means of a metallic diaphragm; it resembles very strikingly a short-exposed photograph of the eclipsed sun, as the prominences on it as distinctly visible, while the presence of streamers and rifts is lacking. Since these photographs were taken, Prof. Hale has been able, by making two exposures on the same plate, to produce pictures each of which displays all the solar phenomena. For the first exposure he employed the metallic diaphragm, allowing the slits which move across it to travel with the velocity required for the prominences; for the second exposure the diaphragm was removed, and the rate of movement of the slits was this time very much increased.

A METEORITE.—In the *American Journal of Science* for August, Mr. H. L. Preston gives an account of the finding of a meteorite in Kenton County, eight miles south of Independence. In the year 1889 during the cleaning out of a spring, something very hard was struck which from the sound was thought to be metal. It was entangled among the roots of an ash tree three or four feet down in the ground, and was not removed from the spot until August 1890, when it was placed in a shed, and more recently bought for the Ward collection of meteorites. The measurements along its greatest diameters were 21 × 14 × 8 inches, and it weighed 359½ pounds. Its surface was covered with numerous but mostly shallow pittings, but was entirely free from crust. An analysis showed that it contained iron to the amount of 91·59 per cent., nickel 7·65, cobalt 0·84, carbon 0·12, with traces of copper and sulphur.

MOUNTING OF OBJECTIVES.—A novel but very useful way of mounting objectives is that adopted by Prof. Hale, who has added another object glass to his equatorial. What he has done has been to employ a twin cell in which the glasses have been placed; the whole is then hung on an axis fixed rigidly to the side of the telescope tube so that by a simple rotation each glass, whether for photographic or for visual purposes, can be brought to the centre of the front of the tube. In order to make use of that objective which is not temporarily required for the main instrument, a tail-piece near the eye-end is also mounted, thus completing another telescope, only without a tube. One great disadvantage of this arrangement would be the difficulty of centring the lenses after each change, but this is not so as we are informed, no difficulty at all being experienced. In *Astronomy and Astro-Physics* for August, there is shown a picture of Mars emerging from occultation on July 11, taken without the tube. In the original photograph, which is about $\frac{1}{32}$ inch in diameter, the polar caps on the planet are clearly shown together with some of the other markings on the surface.

JUPITER.—During the next two months the planet Jupiter will be in a very good position for observation. This year he is as much as 5° to 8° north of the equator, being situated now in the constellation of Pisces, just north of the two stars μ and ν. The next opposition occurs on the 12th October.

NOVA AURIGÆ.—In a communication to the *Daily Graphic*, the Rev. A. Freeman gives the results of some observations of the revived new star in Auriga, made by him on Sunday, August 28. Adopting Mr. Stone's values for the magnitudes of the neighbouring stars, the nova would appear to have then been a trifle brighter than mag. 10·3, but decidedly fainter than 9·7. By comparison with the zone star +30° 924. the nova was rated at mag. 10·1. As Mr. Espin estimated it to be 9·2 on August 21, it is probable that the star is again waning.

From the Astrophysical Laboratory at South Kensington we have received the following:—There was no opportunity of observing the nova here until 1.30 a.m. on Thursday, September 1, and it was then too dim to be readily seen with the 10-inch refractor. A photograph of the region was taken with the 3½-inch portrait lens, the exposure being thirty minutes, but this failed to show the nova, although clearly showing stars of the 10th magnitude.

COMET SWIFT, MARCH 6, 1892.—The following is a continuation of the ephemeris for Comet Swift, which we take from *The Edinburgh Circular*, No. 29:—

1892.	R.A. h. m. s.	Decl. ° ′	log. Δ.	log. r.	Br.
Sept. 8	0 32 27	+51 56·5			
9	31 8	51 48·8			
10	29 49	51 40·7	0·2751	0·4085	0·073
11	28 30	51 32·1			
12	27 10	51 23·2			
13	25 50	51 13·9			
14	24 30	51 4·1	0·2788	0·4164	0·069
15	23 11	50 54·0			

Brightness at time of discovery is the unit of Br.

The Edinburgh Circular, No. 30, announces the discovery of a comet by Mr. Brooks, at Geneva, U.S., at midnight on the 29th ult. The comet was then in R.A. 6h. 20min. and declination 31° 48′ north, its daily motion being +1min. 44sec. and 2′ south. The same comet has also been observed at Kiel on the 31st inst. at 12h. 32·2min.; its place then was found to be R.A. 6h. 5min. 59·1sec. North declination 31° 42′ 27″. Whether this comet is a new one or not cannot of course be said yet for certain, but it is neither Brooks' 1886 IV. nor Tempel 1867 II. if we can depend on the two search ephemerises we have at hand, for their declinations in both instances should be at this time over 30° south.

GEOGRAPHICAL NOTES.

MONTENEGRO, though one of the smallest, is certainly one of the least known countries in Europe. Dr. K. Hassert, who has already made important journeys in the less known parts of the Balkan peninsula, is this summer travelling through Montenegro, and describes the scenery as in many places of very great beauty. The frontier river Cijevna flows through a steep-sided gorge, the height of the precipices bordering which he estimates as over 3000 feet, while in its appearance it rivals the cañons of the Colorado. The traveller in this part of the country runs considerable risks from the predatory Albanian tribes.

THE *Times* publishes a telegram from Captain MacDonald of the Mombasa-Victoria-Nyanza Survey, announcing that the Survey had found a good route for a railway to Sio Bay on the Nyanza, and had returned to Kikuyu on August 8. The Survey work has been carried on rapidly, and, which is more important, without any fighting.

RAILWAYS in tropical Africa may ultimately derive more revenue from native passengers than might be anticipated. The railway from St. Paul de Loando is being pushed forward to Ambaca, and now nearly reaches Casengo, where there are flourishing coffee plantations under Portuguese management. Until this point is reached the revenue from goods cannot be large, but the natives having speedily got over their distrust of the innovation, now travel freely by rail in large numbers.

PROF. POUCHET has this summer succeeded in visiting Jan Mayen Island and Spitzbergen in the French gun-boat *La Manche*. Jan Mayen, on which a landing had not been made for ten years, was visited on July 27, and the vessel proceeded to Spitzbergen, where a fortnight was spent. The west coast was followed up to 78° N., and some excursions made on foot into the interior. Glacier phenomena were studied, and collections of native fauna and of fossils made. The sea was found to be entirely free from ice.

NEWS has recently been received in Copenhagen of the safety and success of the East Greenland Expedition, which left Denmark in June 1891 under Lieutenant Ryder. The expedition passed the winter on the Greenland coast in Scoresby's Land at a point in 70° 27′ N. Important scientific results have been obtained, but the expedition is not yet over, Lieutenant Ryder intending, after a short visit to Iceland, to make an attempt to trace out the hitherto unvisited coast-line between 70° N. and the Arctic circle.

THE first chart on which the American continent appears is being reproduced in facsimile for the approaching Columbus Exhibition in Madrid. The following details are given in a Reuter telegram from Madrid. The work, which is now approaching completion, is being done by Señor Canovas Vallejo, a nephew of the Spanish Premier, and by Prof. Traynor. The original chart, which was traced in the year 1500 by the famous navigator and cartographer Juan de la Cosa, who acted as pilot to Columbus in more than one of his voyages across the Atlantic, has been since carefully preserved in the Naval Museum in Madrid. The chart presents some most interesting features, displaying, as it does, the extent of the knowledge of the best-informed geographers of the day. On it are depicted the West Indies and a small portion of South America—namely, the north-eastern section lying between the River Amazon and Panama. To this land the general name of Tierra Firme is given, to mark the contrast between the continent and the Antilles. Here and there are traces of modern names, such as Venezuela, Maracaibo, and Brazil. The chart even comprises some particulars of the discoveries made in Northern America by Sebastian Cabot in 1497, and such titles as these:—"Sea discovered by the English," "English Cape," "Lizard," and "St. George." La Cosa has also clearly depicted Cuba as an island, whereas Columbus died in the belief that it was a continent, and it was not until eight years later that the correctness of La Cosa's chart was in this respect finally established.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ROCHESTER MEETING.

THE forty-first annual meeting of the American Association for the Advancement of Science was held at Rochester, New York, August 17–23, Prof. Joseph Le Conte, of California, the well-known geologist, presiding.

Rochester is one of the most beautiful of American cities, being laid out quite on the *rus in urbe* principle, so that each residence is generally surrounded by grounds, instead of being built in a solid block. It is pre-eminently a city of freeholders, as appears by the fact that a recent census showed more landowners than voters in the city. It is moreover situated in the beautiful and picturesque region of western New York, within a very short distance from numerous glacial lakes, as well as the

Falls of Niagara. The fertile valley of the Genesee was long ago renowned for its wheat as it now is for its fruit and flowers, and Rochester, formerly called the flour city, is now known as the city of flowers. The river flows through the city, falling in pretty cascades to a wild glen, and furnishing the water power which is utilized in flouring mills and other manufactures. Lake Ontario is a few miles distant, but yet it is so far away, and the navigation of the Genesee is so restricted, that Rochester is considered an inland city, and it is the largest inland city in the United States, having a population of 144,000.

The meeting of the Association coincided in time with the railroad strikes at Buffalo, some seventy miles distant, where several regiments of militia were stationed at that time to protect the railroads from mob violence. The sense of insecurity doubtless deterred a few members from attending, though the attendance was above the average.

For the last few years, specialists have shown a growing tendency to organize special societies outside of, though affiliated to, the general Association. This year the larger meeting was preceded by meetings of the American Microscopical Society, the Geological Society of America, the Society for the Promotion of Agricultural Science, the Association of Economic Entomologists, and this year was organized the American Association of State Weather Services. The latter is composed of weather observers from the several States of the Union. Every State now has a weather-observing station, and an observer co-operating with the general government.

The first day of the meeting was taken up with opening general exercises, organizing the sections, and addresses by the retiring president, Prof. Albert B. Prescott, of Ann Arbor, and the presidents of the several sections, namely, mathematics and astronomy, J. R. Eastman; physics, B. F. Thomas; chemistry, Alfred Springer; mechanical science and engineering, J. B. Johnson; geology and geography, H. S. Williams; biology, S. H. Gage; anthropology, W. H. Holmes; economic science and statistics, Lester F. Ward.

The remaining days of the meeting were given to reading of papers in the various sections, after a brief business meeting in general session. The general business included a division of the biological section into Section F, zoology, and Section G, botany, the former Section G, microscopy, having been abolished years ago. The biological section has long been overcrowded.

The preservation of forests has been and is one of the most important economic matters of our age. Reckless and wasteful methods have prevailed to such an extent that many fine forests have been ruined, and others are rapidly going to ruin. The large areas still owned by government are subject to the double peril of robbery and fire. Mr. Fernow, chief of the Bureau of Forestry, in a paper before the economic section, stated that the annual loss to the government by thieves is 10,000,000 to 15,000,000 dols., while that by fire is probably twice as much more. To protect the twenty thousand square miles of government forest land, a paltry force of twenty to twenty-four watchmen is employed, and even these are not clothed with sufficient authority. They are barely able to reclaim some 100,000 dols. worth of timber annually from depredators, which only suffices to repay the expense of maintaining the service. Proper protection would require an annual outlay of 2,000,000 dols. to 3,000,000 dols., and would preserve 20,000,000 to 50,000,000 dollars' worth of property in each year. The section recommended a resolution favouring suitable legislation, such as is embodied in the bill introduced by Senator Paddock, and the resolution was unanimously adopted in general session.

Much interest was manifested in the approaching World's Columbian Exposition at Chicago. Prof. F. W. Putnam, permanent secretary of the Association, is also chief of the department of ethnology, &c., at the Exposition. In a paper before the anthropological section he detailed plans adopted for taking anthropmetrical measurements of native American tribes, also of children in public schools, both white and others, as well as children in the Indian schools. An exhibit of special interest will be a collection of representatives of all the native American tribes, including a family from each tribe, engaged in native industries. This will require the gathering of at least five hundred aborigines, and probably more than that number, and it will be the last opportunity when such an exhibit can be made, since the extension of railroads and other appliances of civilization is rapidly subverting aboriginal methods and conditions; the tribes are becoming disintegrated and amalgamated, and machine-made articles are supplanting those by hand.

Committees were appointed from each section to co-operate with other organizations having similar aims, in holding joint meetings during the Exposition. By resolution in general session the Secretaries of the several sections were appointed a committee to co-operate with the World's Congress Auxiliary in securing space for each section for the entire time of the Exposition in which to register as headquarters for that section, and similar organizations, both foreign and domestic.

Thursday evening was occupied with a reception by the Women's Reception Committee of the Local Committee at the Powers Art Gallery. This is by some considered to be the finest art collection in America, including pictures by Diaz, Corot, Millet, Verboeckhoven, Gérome, Munkacsy, Doré, Bonheur, Vibert, Bougereau, Zimmerman, Cooman, Leloir, Hagborg, Schreyer, Henner, Le Rolles, Knaus, Jackobides, Defregger, Daubigney, Rousseau, and other foreign artists, besides works of the best American artists, and copies of Rubens, Titiens, Raphael, Correggio, and others.

Besides the annual address of the retiring President, Prof. Prescott, only one other address was made in general session. This was by Dr. Joseph Jastrow on Friday evening on "Hypnotism and its Antecedents." In the first part of his lecture he gave a historical sketch of the development of hypnotism, and described various procedures in which it is involved. The careers of Messmer and other early hypnotists were sketched, up to the time when it obtained scientific recognition about fifteen years ago through the efforts of Charcot and Richet. The second part of the lecture described the chief phenomena of modern hypnotism as revealed and recognized during the last score of years. The lecturer illustrated the illusions of sense in various ways, and described in detail the methods of inducing the state. In some instances, it was stated, the subject may not lose control, but simply finds it impossible to resist the demands of the operator. For instance, upon being told that he cannot open his eyes, he finds it impossible to do so, though perfectly conscious; a cane placed in his hands he is unable to drop, and fingers set in motion he is powerless to stop. Many interesting phenomena were cited. One of the most curious of these is what is termed the post-hypno suggestion. While the subject is asleep it is suggested that he shall perform some act at a certain time after awakening. These acts are performed by the patient, sometimes even when the time set to elapse has been a year. But perhaps the most surprising of all the phenomena cited was the control of the patient over involuntary powers. Upon being told that a postage stamp placed on the arm is a plaster which will raise a blister, the effect is actually accomplished. Sometimes the mere tracing of a line upon the skin has produced the same effect. In some cases rigidity of the muscles is induced, so that the arm may be kept extended or the body may be rigidly supported, with the head on one chair and the feet on another, for a long time. Important legal questions may be raised as to the responsibility of hypnotized patients. Crimes may be committed at the instigation of the operator. It has long been known that petty crimes could be so caused. It is found also that the gravest crimes are equally controlled, as shown by repeated instances where the patient was given a dagger and told to stab a person lying on a certain cot in the hospital, which the patient did, though the person stabbed was only a straw figure, but so covered as not to be recognized as such. The control over the nervous system renders hypnotism a valuable remedial agent in paralysis, aphasia, tetanus, and many other diseases controlled by or specially related to the nervous system.

Another lecture, which was practically tantamount to a public address before the Association, was that of G. K. Gilbert, President of the Geological Society of America, before the Rochester Academy of Sciences, on "Coon Butte and Theories of its Origin." This extinct crater, located in Eastern Arizona, is unique in showing no signs of lava or scoriæ, and also in the fact that meteoric iron is found abundantly near it, numerous specimens, one of them over 600 pounds in weight, having been picked up here. This suggested to Prof. Gilbert the hypothesis that the crater may have been caused by the impact of a larger meteor, sufficient to make such a hole three-quarters of a mile in diameter, just as a cannon ball fired into a target would do, especially as the general appearance of this crater is remarkably similar to that of some results caused by projectiles. To test the correctness of this theory, he caused a careful magnetic and geodetic survey to be made to determine whether any large mass of iron was buried beneath the crater, and also whether the rim exceeded the crater in bulk sufficiently to indicate a mass of matter in the rim larger than would be caused by the displacement of the material removed from the crater. Both these surveys, however, gave negative results. The magnetic survey indicated that if any considerable mass of iron exists there it is buried at least fifty miles deep, and a comparison of the quantity of matter in the rim shows no more than would fill up the space of the crater. He was compelled, therefore, to abandon the meteoric theory, notwithstanding that the chances of the fortuitous concurrence of such a crater accompanied by such a meteoric downfall is only one in five thousand. The origin of the butte must therefore be an explosion of steam.

The president elect of the Association, Prof. William Harkness, of Washington, was born at Ecclefechan, Scotland, in 1837, where his father, Rev. James Harkness, resided till 1839, when the family removed to America. The father was for a while pastor of a church at Rochester, where the son was educated, after having spent part of his college life at Lafayette College, in Pennsylvania. He graduated at the University of Rochester in 1858, and received from the same university the degree of doctor of laws in 1874. It was, therefore, peculiarly appropriate that he should be elected to the presidency at the Rochester meeting.

Prof. Harkness studied medicine, and practised as an army surgeon in 1864; but, with the exception of a short time in the army, he has been employed by the Government as an astronomer for about thirty years. During the total eclipse of 1869, he discovered the 1474 line of the spectrum of solar protuberances. He became prominent in observations of the transits of Venus.

It is difficult to select the most important and valuable papers from the whole number of 182 read before the several sections, but a few abstracts will be subjoined which appear to merit notice.

George E. Hale, of Chicago, read a paper before the astronomical section on "The Spectroheliograph of the Kenwood Astro-physical Observatory, Chicago, and results obtained in the study of the Sun." He described the ingenious apparatus which he had invented and perfected for photographing the faculæ and protuberances of the sun. This apparatus gives by far the most perfect pictures ever taken, and is the first which has successfully photographed the bright spots, showing faculæ which the eye cannot detect. Means were devised for taking on the same plate at one exposure both the faculæ and the protuberances, and Prof. Hale exhibited the first complete picture of the sun ever taken. Comparison with the best plates made at the Lick Observatory showed the great superiority of the work at Chicago. An observation of unusual interest was made on July 15, 1892. A photograph of the sun showed a large spot. A few minutes later another photograph was taken, which, when developed, showed that the bright band had appeared since the last exposure. Twenty-seven minutes thereafter another photograph showed that almost the entire spot was covered with brilliant faculæ, which by the end of an hour had entirely disappeared, leaving the spot as at the first exposure. This indicates an eruption proceeding with indescribable and inconceivable velocity. This disturbance seems to be connected with magnetic disturbances and the brilliant aurora noted the next day. The section, with much enthusiasm, passed a vote of thanks to Prof. Hale for his researches.

Edwin B. Frost read a paper on "Thermal Absorption in the Solar Atmosphere." Among the interesting phenomena observed were some cases where the umbra of sun spots radiated more heat than the neighbouring photosphere, indicating either that the dark spot is at a higher elevation than the surrounding photosphere, and consequently loses less heat by absorption of the sun's atmosphere, or that it is attended by an invisible facula.

Prof. R. S. Woodward described the iced-bar base apparatus lately devised by him for the Coast and Geodetic Survey. This is a line measure, micrometer microscope apparatus. The measuring bar is of steel, five metres long, and its temperature is kept constant by a packing of melting ice. The use of thermometers is thus avoided entirely. From results submitted by the author it appears that the total probable error of one measure with this apparatus of a distance a kilometre or more in length will not exceed one part in four to five millions.

One of the most important uses to which Prof. Woodward has applied the iced-bar apparatus is that of showing that long steel tapes, when properly handled, will give from one measure the length of a line, a kilometre, or more long with a probable error not exceeding one part in a half-million. Considering that this can be done at the rate of two kilometres per hour with a 100-metre tape, it would seem that such tapes must soon take high rank amongst apparatus for measuring bases.

Prof. W. A. Rogers read two papers before Section D, the first of which was a description of a standard yard and metre upon polished steel. The standard, which was exhibited, had upon one edge a metre subdivided by 20 millimetres and 40 inches subdivided to tenths of inches. Both are standard or 62° Fahr. It appears from an investigation of these standards that 772 of the separate millimetres have errors not exceeding one mikron, and that of the 400 tenth-of-inch spaces 280 have errors not exceeding one-twenty-five-thousandth of an inch.

Prof. Rogers read a second paper on an investigation of a 21-foot screw. This screw was made by the Pratt and Whitney Company for R. Hoe and Co., of New York. It appeared from this investigation that the pitch of this screw was very regular in its character, but that the linear error amounted to nearly one-hundredth of an inch in 21 feet. A part of this is undoubtedly due to flexure, but a part is due to changes of pitch in the screw itself.

In the section of anthropology Permanent Secretary F. W. Putnam gave an interesting talk on "Copper Implements and Ornaments in the Ohio Mounds." He emphatically denied the statements that these copper instruments were fashioned by white men and given to the Indians in trade. "It must be," said he, "that these implements were made by the native Americans. In all cases where implements and ornaments are found in these mounds there are found also on the altars nuggets of copper. So it is with the silver implements and those made of meteoric iron. Now, is it likely that the trader would furnish the Indian with nuggets of the natural material? There is conclusive proof that the original settlers of the Ohio Valley worked the metal into these implements and ornaments. Again, many of these mounds have trees growing on them that are between 400 and 500 years old. This carries them back beyond the time of trading." Prof. Putnam explained that holes could be cut in the sheet copper which had been hammered out by the Indian by simply placing the sheet of copper on the trunk of a tree and pounding into it one end of an oak limb squared. He was unable to describe the probable mode adopted by the Indians in cutting edges shaped like the teeth of a saw, but thought it was done by the use of an instrument made of meteoric iron.

In the section of biology, C. V. Riley read a paper on "Fertilization of the Fig and Caprification." In the production of the best Smyrna figs certain minute insects perform an essential function in fructifying the fig. The process is called "caprification," and has been performed by the aid of fig-growers ever since the time of Aristotle. The cultivator is accustomed at a certain season to place the fruit of the "caprifig," which contains these insects, on the fig tree which contains the edible fig. The caprifig does indeed produce a fig, but it is small and insipid. The tree which produces the edible fig does not yield fruit of fine flavour unless it is thus fertilized by the aid of these insects, the scientific name of which is Blastophaga psenes. The absence of these explains the insipidity of figs raised in California. There are, indeed, a dozen species of Blastophagæ found in America, but it is improbable that any one of them is adapted to the fertilization of the Smyrna fig, which growers there are trying to cultivate. The caprifig, however, is already well established, and the desideratum seems to be to introduce the insects. This, Prof. Riley thinks, can be done by gathering the fruit containing them in Smyrna and rapidly transporting it to California, which, he urges, should be undertaken by the Government. An attempt was made last summer by J. Shinn, of Niles, Alameda County, California. The fruit containing insects was gathered at Smyrna in the last days of June and received at Niles on July 23, within twenty-five days, but it is not known whether the experiment was successful.

In the section of physics, several valuable papers were contributed by G. W. Hough, A. E. Dolben, W. L. Stevens, E. L. Nichols, B. W. Snow, and others. One of the most interesting papers giving results of original research was by Edwin S. Ferry on "Persistence of Vision."

Prof. Frank P. Whitman, in a brief paper on the "Magnetic Disturbances caused by Electric Railways," gave the following results of recent observations:—"No magnetic instruments dependent on the earth's field can be used for reasonably accurate work at less than 1500 feet from an electric railway, and the distance must be made greater still if the building in which the instrument is placed is fitted with a system of iron pipes. Minor galvanometers must use iron shields and artificial fields, while earth indicators and other similar methods of finding the constant of a ballistic galvanometer must be abandoned. Experiments are under way for providing the thinnest shield of soft iron which will serve as complete protection to magnetic instruments under such conditions as just mentioned."

The preliminary meetings of affiliated societies drew off much material which would otherwise have been presented to the chemical and zoological sections.

Prof. Robert T. Hill read to the geological section a paper on "The Volcanic Craters of the United States," in which he said:—"At the present moment, when many of the great volcanoes of the world are in activity, Vesuvius and Etna in Europe, others in the Australian region, and Colima in Mexico, I thought it a good idea to review the many beautiful volcanic craters found in our own land. The great cinder cones of New Mexico, Arizona, California, and Oregon are among the most interesting. The most eastern crater in the United States is Mount Capulin, a vast mountain in New Mexico. This is composed of volcanic cinder, which looks very much like that which comes from a locomotive. It rises 2750 feet above the plain on which it stands. It is twelve miles in circumference at its base. Were it situated in the eastern part of the United States it would be considered one of the greatest objects of natural interest, but in the West, where the phenomena are so abundant, it is hardly noticed and it has not found a place on the maps. In Arizona and New Mexico over 300 old volcanic necks or 'pipes' are found, and there are 20,000 square miles of lava which has flowed from them. The recent earthquakes in California were shown to have been produced by the terrific volcanic disturbances in Western Mexico."

Prof. Hill thinks it probable that the extinct volcanoes in the United States may again become active. The volcanic region has only been known about fifty years, and experts say that appearances indicate eruptions within two hundred years past.

The next meeting of the Association will be held at Madison, Wisconsin, on the third Thursday of August, 1893, unless the date shall be changed by the council.

Cordial invitations from the city government of San Francisco, the California Academy of Science, the University of California, and the new and munificently-endowed Leland Stanford, Jun., University, indicate that a meeting at San Francisco will be arranged for 1895.

THE INTERNATIONAL CONGRESS OF ORIENTALISTS.

THE meetings of the International Congress of Orientalists are being held this week in London, and the proceedings, which are of great interest, have been attracting a good deal of popular attention. The Congress is being attended not only by a large number of British scholars, but by many representatives of other countries, among whom are the following:—Austria-Hungary: Prof. G. Bühler, the Rev. Joseph Dahlmann, Dr. I. Goldziher, Dr. J. Karabacek, Prof. L. Reinisch; Belgium: Dr. Abbeloos; Egypt: Dr. Vollers; France: Prof. J. Darmesteter; Germany: Prof. K. Abel, Prof. R. E. Brünnow, Prof. Geiger, Prof. Hommel, Prof. Hübschmann, Dr. G. Huth, Prof. Kautzsch, Prof. Kielhorn, Prof. Leumann; Holland: Prof. J. P. N. Land; Italy: Prof. Ascoli, Dr. Carlo Formichi, Count Angelo de Gubernatis, Dr. Pavolini; Sweden and Norway: Dr. Karl Piehl; United States of America: Prof. Charles Lanman, Mr. W. H. Ward.

At the opening meeting on Monday, Prof. Max Müller delivered his presidential address. After some preliminary observations, in the course of which he expressed the obligations of the Congress to the Duke of York for having consented to act as honorary president, Prof. Müller spoke of the splendid service which has been rendered by Oriental scholarship in proving that in prehistoric times language formed a bond of union between the ancestors of many of the Eastern and Western nations, and that in historic times also, language, which seemed to separate the great nations of antiquity, never separated the most important among them so completely as to make all intellectual commerce and exchange between them impossible. These two discoveries seemed to him to form the highest glory of Oriental scholarship during the present century. It was often supposed that students of Oriental languages and of the science of language dealt with words only. Even now, when scholars spoke of languages and families of languages, they often forgot that languages meant speakers of languages, and that families of speech presupposed real families, or classes, or powerful confederacies which have struggled for their existence and held their ground against all enemies. "Languages," said Prof. Müller, "as we read in the book of Daniel, are the same as nations that dwell on all the earth. If therefore Greeks and Romans, Celts, Germans, Slavs, Persians, and Indians, speaking different languages, and each forming a separate nationality, constitute, as long as we know them, a real historical fact, there is another fact equally real and historical, though we may refer it to a prehistoric period, namely, that there was a time when the ancestors of all these nations and languages formed one compact body, speaking one and the same language, a language so real, so truly historical, that without it there would never have been a real Greek, a real Latin language, never a Greek Republic, never a Roman Empire; there would have been no Sanskrit, no Vedas, no Avesta, no Plato, no Greek New Testament. We know with the same certainty that other nations and languages also, which in historical times stand before us so isolated as Phenician, Hebrew, Babylonian, and Arabic, presuppose a prehistoric, that is, an antecedent powerful Semitic confederacy, held together by the bonds of a common language, possibly by the same laws and by a belief in the same gods. Unless the ancestors of these nations and languages had once lived and worked together, there would have been no common arsenal from which the leading nations of Semitic history could have taken their armour and their swords, the armour and swords which they wielded in their intellectual struggles, and many of which we are still wielding ourselves in our wars of liberation from error, and our conquests of truth."

With regard to the question as to the exact part of the world where these consolidations took place, no definite or positive statement could be made. Nothing, however, had shaken his belief—he did not call it more—that the oldest home of the Âryas was in the East. All theories in favour of other localities, of which so much had been said lately, whether in favour of Scandinavia, Russia, or Germany, rested on evidence far more precarious than that which was collected by the founders of comparative philology. There was also a difference of opinion as to the original home of the Semites, but all Semitic scholars agreed that it was "somewhere in Asia." With regard to time the difficulties were still greater; but Prof. Müller expressed the opinion that if we must follow the example of geology and fix chronological limits for the growth of the Proto-Aryan language, previous to the consolidation of the six national languages, 10,000 B.C. would by no means be too distant as the probable limit of what he would call our historical knowledge of the existence of Aryan speakers somewhere in Asia. There must also have been a long period previous to the formation of the great Semitic languages, because thus only can the fact be accounted for that on many points so modern a language as Arabic is more primitive than Hebrew, while in other grammatical formations Hebrew is more primitive than Arabic. Whether it was possible that these two linguistic consolidations, the Aryan and Semitic, came originally from a common source was a question which scholars did not like to ask, because they knew it did not admit of a scholarlike answer. Another question also which carried us back still further into unknown antiquity, whether it was possible to account for the origin of languages or rather of human speech in general, was one which scholars eschewed, because it was one to be handled by philosophers rather than by students of language. The deeper we delved the farther the solution of this problem seemed to recede from our grasp; and we might here too learn the old lesson that our mind was not made to grasp beginnings. And yet, though accepting this limitation of their labours as the common fate of all human knowledge, Oriental scholars had not altogether laboured in vain. No history of the world could in future be written without its introductory chapter on the great consolidations of the ancient Aryan and Semitic speakers. It might be said that this great discovery of a whole act in the drama of the world, the very existence of which was unknown to our forefathers, was due to the study of the Science of Language rather than to Oriental scholarship. But where would the Science of Language have been without the students of Sanskrit and Zend, of Hebrew and Arabic? "At a

Congress of Orientalists we have a right to claim what is due to them, and I doubt whether anybody here present would deny that it is due in the first place to Oriental scholars, such as Sir W. Jones, Colebrooke, Schlegel, Bopp, Burnouf, Grimm, and Kuhn, if we now have a whole period added to the history of the world, if we now can prove that long before we know anything of Homeric Greece, of Vedic India, of Persia, Greece, Italy, and all the rest of Europe, there was a real historical community formed by the speakers of Aryan tongues, that they were closely held together by the bonds of a common speech and common thoughts. It is equally due to the industry and genius of Oriental scholars such as de Sacy, Gesenius, Ewald, and my friend the late Prof. Wright, if it can no longer be doubted that the ancestors of the speakers of Babylonian and Assyrian, Syriac, Hebrew, Phenician, and Arabic formed once one consolidated brotherhood of Semitic speech, and that, however different they are when they appear for the first time in their national individuality on the stage of history, they could once understand their common words and common thoughts, like members of one and the same family. Surely this is an achievement in which Oriental scholarship has a right to take pride, when it is challenged to produce its title to the gratitude of the world at large."

Turning to another field, Prof. Müller showed that Oriental scholars had inspired the oldest period in the history of the world with a new life. Instead of learning by heart the unmeaning names of kings and the dates of their battles, whether in Egypt or Babylon, in Syria or Palestine, we had been enabled, chiefly through the marvellous discoveries of Oriental scholars, to watch their most secret thoughts, to comprehend their motives, to listen to their prayers, to read even their private and confidential letters. The ancient history of the world might be said to have assumed, under the hands of Oriental scholars, the character of a magnificent dramatic trilogy. The first drama told us of the fates of the Aryan and Semitic races, as compact confederacies before their separation into various languages and historical nationalities. The second drama was formed by the wars and conquests of the great Eastern Empires in Egypt, Babylon, and Syria, but it showed us that besides these wars and conquests, there was a constant progress of Eastern culture towards the West, towards the shores and islands of the Mediterranean, and lastly towards Greece. The third drama represented the triumphant progress of Alexander, the Greek far more than the Macedonian, from Europe through Persia, Palestine, Phenicia, Egypt, Babylon, Hyrcania, and Bactria to India, in fact through all the great empires of the ancient East. Here we saw the first attempt at re-establishing the union between East and the West.

Prof. Müller concluded his address with an eloquent and impressive plea for the encouragement of Oriental studies in England. "When," he said, "I accepted the honourable post of president of this congress, it was chiefly because I hoped that this congress would help to kindle more enthusiasm for Oriental scholarship in England. But that enthusiasm must not be allowed to pass away with our meeting. It should assume a solid and lasting form in the shape of a permanent and powerful association for the advancement of Oriental learning, having its proper home in the Imperial Institute. If the members of this congress and their friends will help to carry out this plan, then our congress might hereafter mark an important epoch in the history of this the greatest Eastern Empire, and I should feel that, in spite of all my shortcomings, I had proved not quite unworthy of the confidence which my friends and fellow-labourers have reposed in me."

A vote of thanks to Prof. Müller for his interesting address was moved by Prof. von Bühler, seconded by Count de Gubernatis, and carried with enthusiasm.

On Tuesday the work of the sections was proceeded with. Special interest was given to the proceedings on Wednesday by the reading of an address written by Mr. Gladstone, for the section dealing with Archaic Greece and the East.

THE ERUPTION AT SANGIR.

ON Friday last the *Times* printed some interesting extracts from a letter (dated Labuan, July 11, 1892) by Mr. George Ormsby, a magistrate in the British North Borneo Company's Service, containing an account of the recent eruption in Sangir, and of a visit paid to the spot immediately afterwards. Mr. Ormsby left Sandakan on June 4 in the s.s. *Normanby*, and arrived at Menado on the morning of the 7th. After a visit to Govontalo the vessel returned to Menado on the 10th, and here Mr. Ormsby heard that there had been an eruption on some of the islands to the north, and that the s.s. *Hecuba*, which had arrived at Menado just after the *Normanby* had started for Govontalo, had been chartered by the Dutch Government, and had gone out to find the scene of the eruption and to render assistance. On the 12th the *Hecuba* was sighted coming into Menado, and Mr. Ormsby and the skipper of the *Normanby* went on board as soon as she dropped anchor. "The captain," says Mr. Ormsby, "told us that he first went to an island called Siow, as the volcano there was known to be active. He found the island covered with ashes, but was told that the eruption had taken place at Sangir, an island about 30 miles further north. He went on there, and found it buried in ashes; they were digging the houses out at Tarona, the port. The cocoanut trees were all destroyed, and the loss of life was unknown. The volcano was slightly in eruption when he arrived. He went along the coast, stopping at the villages, and sending rice ashore, as the people were without food. He said some of the people were frightfully burned and maimed."

When the Dutch official who was on board the *Hecuba* reported the state of affairs to the Resident, the *Normanby* was chartered to take rice to the island and land it at Tarona. She left Menado at midnight, and arrived at Tarona next afternoon. "As we steamed up the coast of Sangir we could see the cocoanuts, with all the leaves broken and hanging downwards and covered with ashes, although the southern end of the island is sheltered from the volcano by hills. The harbour of Tarona is a narrow inlet, about half-way up the western side of the island, with steep hills on each side. The village is on the north side of the harbour, and is sheltered from the volcano by the hills behind it; behind the hills a large plain stretches to the foot of the volcano."

The eruption took place on the 7th at 7 p.m., and there was a slight eruption on the 9th, followed by heavy rain. The only damage done in Tarona was by the weight of ashes; many of the lightly-built native houses were crushed. "The afternoon we arrived," Mr. Ormsby says, "I went ashore, and followed the road from Tarona along the harbour. On rounding the end of the hills the road turned and ran along the northern slope of the hill; down below the road there was a deep ravine, with a small stream at the bottom, which was warm and smelt strongly of sulphur. The ravine was 40 ft. or 50 ft. deep, and had evidently been partly cut out by a stream of mud, which had rushed down it from the foot of the mountain and torn away the road in places. Looking across the ravine towards the crater the whole plain was burnt up, and near the foot of the mountain there was a jet of steam and thick black smoke. On the slope of the crater there was no sign of lava or mud. The three mud rivers I saw started from the foot of the mountain. I followed the road for some distance. About two miles from the sea it crossed a small triangular plain, and then zigzagged up the central range of hills. Where it crossed the plain it was entirely washed away by mud and ashes, which had been hardened by the rain after the eruption. The bridge across the stream was also destroyed, only the butts of the piles remaining. I got up to the top of the hills and a bit down the other side. I had a fine view of the volcano from the top; it was smoking, but there were no fireworks while we were on the island. I noticed a column of steam rising from the plain, close to the foot of the volcano, and determined to try and reach it next morning."

The column of steam was visited next day by Mr. Ormsby and the chief engineer, but they reached it with difficulty. On the way they had to jump a "stream which was steaming, and must have been very hot." He says:—"We went up to where the steam was blowing up through the mud. The mud was quite firm, but so hot that we had to shift from one foot to the other. The steam was puffing up through a lot of holes, but not very strongly where we were. I poked up a lot of stones out of one of the holes with my stick; they were so hot you could not hold them. I let two of them cool a bit, and then rolled them up in my handkerchief and put them in my pocket. One of them was covered with sulphur crystals, but, unfortunately, I lost it as we were returning. The whole place smelt strongly of sulphur, and we soon decided we had had enough of it, as it was about 9 a.m., and between the sun above and the earth below we were both streaming with perspiration. We got back to the ship pretty well fagged, and I stayed on board till we left at 3 p.m. We went direct from Tarona to Sandakan, and as we steamed past the north end of the island I counted 18 jets of steam and smoke on the plain where in the morning there had only been two. The volcano itself was wrapped in smoke, and there were heavy clouds of smoke hanging over the plain. . . . . The Dutch controleur told us that they had already recovered 300 bodies, but that it was impossible to estimate the total loss. He said the other side of the island was worse, lava as well as mud having overflowed there, and that whole villages were buried. No lives were lost in Tarona itself, but forty men from there went into the jungle just before the eruption, and only one got back alive. . . . . We got to Sandakan at midnight on the 16th, and stopped a day there. The eruption was distinctly heard at Sandakan, though it is nearly 500 miles from Sangir."

THE WEST INDIAN FAUNA IN SOUTH FLORIDA.

DR. C. H. MERRIAM has lately published a paper on "The Geographical Distribution of Life in North America" (Proc. Biol. Soc. Wash., April, 1892), which should attract attention on account of the important problems discussed, and the interesting and somewhat novel views advanced. On pp. 49–55 there is a review of the faunal relations of Southern Florida, in which Dr. A. R. Wallace is severely criticized for having stated that Florida is, from a biological point of view, essentially North American, and totally distinct in character from Cuba and the Bahamas, from which it is separated by only a narrow strait. The phrase specially attacked is out of "Island Life," as follows: "Between frigid Canada and subtropical Florida there are less marked differences in the animal productions than between Florida and Cuba."[1]

I well remember that some time ago, when I knew next to nothing of the West Indian fauna, this particular phrase seemed to me very erroneous. An American zoologist cannot fail to be struck with the presence of a colony of West Indian forms in Southern Florida, so distinct from the species and genera of the United States. Following Dr. Merriam's enumeration, we see nine genera of tropical birds, hundreds of tropical insects, a dozen or more land shells, many plants, and so forth. It would seem impossible to doubt that Southern Florida should be referred to the West Indian faunal division in the face of such evidence.

But if we examine the matter from the point of view of a West Indian, who is searching for a fauna in Florida, which is identical, or nearly so, with that of the islands, things look very different indeed. Dr. Wallace's reference was to Florida as a whole, the term "subtropical" being used as descriptive of the State, not of the southern coast only, as used by Dr. Merriam. In the map given by Dr. Merriam, about nine-tenths of Florida are coloured orange, to indicate that they belong to the Lower Sonoran Region of the author. Now this, with the Upper Sonoran, which stretches into Canada, north of Lake Erie, forms the Sonoran, one of Dr. Merriam's primary divisions, the distinction of which from the Tropical region he has so well demonstrated. Furthermore, a large part of Canada is coloured blue on the map, to show that it belongs to the Transition Region between the Sonoran and the Borcal. Hence it appears, from Dr. Merriam's own map, and the statements throughout his paper, that by far the greater part of Florida is more allied faunally to portions of Canada than it is to the West Indies, so far exactly confirming the truth of Dr. Wallace's statement.

This will no doubt be readily admitted by Dr. Merriam, who bases his criticisms on the ground that Dr. Wallace had overlooked the existence of a West Indian fauna along the extreme south coast of Florida. We may, therefore, consider the evidence whereby this limited portion of the State is placed in the Tropical division. For convenience, we may allude to this tract as Tropical Florida, using the term tropical to indicate the climate rather than the fauna.

In order to get at the necessary facts, I have compared the birds of the regions under consideration, using Cory's "Birds of the West Indies" as a guide to the ornithology of the several islands.

Dr. Merriam says that "no less than nine" genera of Tropical American birds inhabit Tropical Florida, and cites nineteen species or subspecies of Antillean birds living in the same area, but not further north.

I find on examining and comparing the West Indian statistics,[1] that no less than 51 genera of West Indian land birds *fail* to reach Florida or any other part of North America. These genera are as follows :—

Mimocichla ; Cichlherminia ; *Margarops ;* Ramphocinclus Cinclocerthia ; Leucopera ; Catharopera ; *Microligea ; Teretistris : Glossiptila ; Laletes ; Dulus ;* Calliste ; *Spindalis ; Nesospingus ; Phœnicophilus ; Calyptophilus ;* Saltator ; *Loxigilla ; Melopyrrha ; Loximitris ; Sicalis ; Nesopsar ; Elainia ; Lawrencia ; Blacicus ; Nyctilius ; Siphonorhis ; Hemiprocne ;* Glaucis ; *Lampornis* ; Eulampis ; *Aithurus ;* Thalurania ; *Mellisuga ; Doricha ; Bellona ; Sporadinus ; Priotelus ; Temnotrogon ; Saurothera* ; *Hyetornis; Todus ; Picumnus* ; *Nesoceleus ; Ara ; Chrysotis ; Gymnasio ; Rupornis ; Regerhinus ; Xiphidiopicus.*

Those printed in ordinary type appear to occur in the West Indies only in the Lesser Antilles.

The number of West Indian species not reaching Florida is of course overwhelmingly great, but here the comparison would be unfair, owing to the large number of representative species, on different islands. In order to obtain a just estimate I have therefore made a list of the land birds inhabiting Cuba which do not occur in Tropical Florida, and the result shows one family (*Todidæ*), 18 genera, and 52 species. There are also a few sub-species.

The list is as follows :—

Icterus hypomelas.
Agelaius humeralis.
,, assimilis.
Sturnella hippocrepis.
Quiscalus gundlachii.
,, atroviolaceus.
Corvus nasicus.
,, minutus.
Pitangus caudifasciatus.
* Saurothera merlini.
* Todus multicolor.
* Xiphidiopicus percussus.
Centrurus superciliaris.
Colaptes chrysocaulosus.
* Nesoceleus fernandinæ.
* Mimocichla rubripes.
,, schistacea.
Myiadestes Elizabeth.
Mimus gundlachi. B.
Polioptila lembeyi.
Dendroica petechia (race gundlachi) B.
,, pityophila.
* Teretistris fernandinæ.
,, fornsi.
* Cœreba cyanea.
Myiarchus sagræ. B.
* Blacicus caribœus.
Tyrannus magnirostris.
Antrostomus cubanensis.
Cypselus phœnicolius.
* Hemiprocne zonaris.
Calypte helenæ.
* Sporadinus riccordi. B.
* Priotelus temnurus.
Petrochelidon fulva.
Viveo gundlachi.
* Spindalis pretrei.
* Melopyrrha nigra.
* Pyrrhomitris cucullata.
Euetheia olivacea.
* Ara tricolor.
Conurus euops.
* Chrysotis leucocephala. B.
Asio stygius.
* Gymnasio lawrencii.
Glaucidium siju.
Accipiter gundlachi.
,, fringilloides.
* Regerhinus wilsonii.
Columba corensis.
,, inornata.
Geotrygon caniceps.

The two species of *Columba* are not definitely given as Cuban in Cory's work but I believe they occur there. Species marked with an asterisk are of genera not reaching Florida; species marked "B" also occur in the Bahamas.

The Bahama Islands also have many birds that are not in Tropical Florida, including some genera, as *Doricha* (two species).

It is thus apparent that, so far as the birds are concerned, the arm of sea between Cuba or the Bahamas and the mainland has been very efficient in preventing the mingling of two faunæ, although a limited number of species have crossed it.

To give many other instances would unduly prolong this letter; but one may cite the land shells as a much more striking case. The land mollusca of Cuba and Florida are almost entirely distinct, the small number (about a dozen[2]) of West Indian forms which have reached Florida is really surprising, considering the favourable currents and the proximity of the two areas. Cuba contains numerous generic and subgeneric types, and hundreds of species, which have never reached Florida.[3]

On the other hand, even on the Florida Keys we get such

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[1] This statement is qualified by a footnote in the new edition of "Island Life," where the existence of some West Indian forms is referred to.

[1] These might be modified in slight details by searching the most recent literature, but Cory's work (1889) is very complete up to the time it was published.

[2] Dr. Merriam cites 20 on Dr. Dall's authority; but several of these are not land shells, but belong to brackish or fresh water.

[3] Thus, Cuba has considerably over 200 species of operculate land-shells which have not reached Florida.

North American types as the subgenera *Polygyra* and *Mesodon* of *Helix* (*H. jejuna*, No Name Key; *H. pustula*, Cedar Keys; *H. carpenteriana*, Key Biscayne; *H. cereolus*, Indian Key, Key West, Egmont Key; *H. septemvolva*, Key West; *H. oppilata*, Cedar Keys (but this is also a Yucatan species); *H. uvulifera*, plentiful on several Keys; *H. auriculata*, Cedar Keys).

How far the birds of Tropical Florida agree with those of the Sonoran region I do not know, having no list at hand from which to glean the facts; but inasmuch as they must greatly exceed nineteen, the number of Antillean forms quoted by Dr. Merriam, it is apparent that the character of the air-fauna cannot be so totally different from that of more northern regions as to justify the proposal to merge it in a different primary faunal division. Dr. Merriam gives a list of the birds which are supposed to be restricted to Southern Florida, comprising two species and seven sub-species; this list emphatically confirms the view that the region in question is really North American (Sonoran), for of the two species, one belongs to a genus which does not occur in the West Indies, and the other to a North American genus which has no endemic West Indian species. The seven sub-species are *all* of North American species, and three of them belong to genera (*Meleagris Cyanocitta*, *Sitta*) which do not exist in the West Indies.

To sum up, the facts seem to be as follows:—The whole of Florida really belongs to the eastern division of the Nearctic region (or to the Sonoran region of Dr. Merriam), but along the southern coast, on land of comparatively recent origin, a number of West Indian forms have appeared, owing to the assistance of currents conveying floating trees, &c., and to the proximity of Cuba and the Bahamas, which has permitted many birds and insects to fly across. These immigrants have formed a distinct colony, but not to any great extent, so far as can be learned, at the expense of the native fauna. The recent appearance of this colony is shown by the fact that (except somewhat doubtfully in the case of a few mollusca) there is at present no tendency to form new endemic species. Mr. Schwarr, who was so impressed with the great number of West Indian insects he found in this region, specially mentions that there were *no endemic forms*.

The northward spread of this colony has doubtless been largely prevented by climate, as stated by Dr. Merriam; but doubtless also quite as largely owing to the *competition of the Sonoran fauna*, for, as Dr. Merriam has himself put it in another connection, "the sustaining capacity of a region is limited; hence such a thing as overcrowding, in the sense of greatly increasing the number of organisms a region can support, is an impossibility."

If climate had been the only barrier, then Tropical Florida should have a fauna like that of Cuba; but so far from doing so, it is still essentially Nearctic, notwithstanding the existence of a very important and interesting West Indian colony. At best it is a transition region.

Under the guidance of Dr. Merriam, researches into the geographical distribution of North American birds and mammals are being energetically carried on; and if I am not mistaken in the above-stated opinions, no doubt information will in due course accumulate that will cause him to withdraw from the position here criticized, and to admit that Dr. Wallace was, in the main, perfectly correct. T. D. A. COCKERELL.

Institute of Jamaica, Kingston, Jamaica,
July 31.

"A NEW SECT OF HERO-WORSHIPPERS."

UNDER this title, the *Japan Mail* describes a curious Society, established in Japan, in honour of Isaac Newton, and which is not a new scientific association so much as a new cult. The day of all the year to the members is Christmas Day, being that on which in 1642 the immortal Newton was born. The constitution is of the simplest. The professors, graduates, and students of the mathematical, astronomical, and physical classes of the Tokio University are *ex officio* members; once a member always a member; and there are no others. The Society was launched as one for undergraduates by Messrs. Fujisawa, Tanaka, and Tanakadate, the first brilliant triumvirate of mathematical graduates which the Tokio University gave to the world. In its early days it met in the students' dormitory. But as the undergraduates developed into graduates and assistants, the professors themselves were drawn into the fold, and a more suitable assembly hall was found in the University Observatory. Now, however, that building is devoted to seismological pursuits. At Christmas, 1890, or Newtonmas, 248, for the first time, the members of the *Newtonkai*, or Newton Association, met in the Physical Laboratory of the Imperial University, to hear each other talk, to distribute appropriate gifts, and to lengthen out the small hours with laughter and good cheer. The Society has no President: a portrait of the august Sir Isaac presides over the scene. It keeps no written records, no minutes; but its traditions are simple, and easily handed down from year to year. The entertainment provided is the work of the second-year students, assisted by those of the first year. Each professor is expected to make a little speech, which is sometimes historical, sometimes whimsical, as the individual spirit may prompt; but it must not be suggestive of the background of a blackboard. The meeting in fact is essentially social; and in the preparation of the magic lantern slides, the committee of management lay themselves out for frolic and jest. The picture may represent a comical incident familiar to most of the members, or it may be a pictorial conundrum to guess. It was a fine humour, for instance, which gave a caricature of one student notorious for his indefatigable asking of questions. This youth was shown labouring under a shoulder beam, from which hung two buckets filled to overflowing with points of interrogation; while in the background was seated one of the professors, perfectly aghast as this mathematical labourer approached with his load. After the magic lantern exhibition comes the lottery for presents. This is a great feature, productive of much merriment. Each person draws a paper, which may be blank, but usually has a name on it. This name may be one of the illustrious living, or the still more illustrious dead. Corresponding to each name is an article, which, with all solemnity, is presented to the holder of the paper. The connection between the article and the name is more or less symbolic, or it may rest on a far-fetched pun, to which the Japanese language readily lends itself. Usually the jokes are very technical; but occasionally they appeal to a circle more wide than mathematical. Thus the drawer of "Newton" got an apple, and the drawer of "Franklin" a kite. "Herschell" (Sir John) was represented by a sprig of *Nanten* ("southern heavens," which he surveyed); "Archimedes," by a naked doll supposed to be returning from the bath; while the holder of "Kant-Laplace," got a puff of tobacco smoke blown in his face, symbolic of the nebular hypothesis. Some time ago it was pointed out by a European member of the *Kai* that in holding the "Newtonmas" on Christmas Day the members were guilty of a chronological crime hardly to be excused in men trained in the accurate school of Newton. For although he was registered as being born on Christmas Day, 1642, it was Christmas Day, old style. In all strictness he was born on January 5, 1643. But the great convenience of having the *fête* at the beginning rather than towards the end of the winter vacation, and the avoidance of clashing with Japanese New Year festivities, were sufficient to outweigh all other considerations whatsoever. Besides, did not Newton himself hold his birthday on Christmas Day? Why, then, should his admirers hold it on any other? After all, concludes the Yokohama journal, the peculiar interest of the "Newtonmas" lies in its existence. Only to the hero-worshipping Japanese has it occurred thus to pay honour to the memory of the greatest mathematical sage of all time. Very few English-speaking naturalists, to use the word in its widest and legitimate sense, are even aware that Christmas Day in 1642 beheld the birth of Newton. It is possible that nearly fifty years ago a bicentenary *fête* was held in Cambridge; and it is very probable that about fifty years hence Newton's tercentenary will be celebrated in England—perhaps over all the civilized world. But an annual celebration by a Newton Club outside Japan is a thing not to be dreamed of, unless Japan influences the hero-worshipping instinct of the Western people as profoundly as she has influenced their æsthetic taste.

SCIENTIFIC SERIALS.

Royal Society of Victoria, Vol. 3 (N.S.), *Proceedings*, Part I. contains Notes on West Australian oology, by A. J. Campbell (Pls. 1 and 2); On some Victorian fishes, with descriptions of *Cristiceps wilsoni*, *C. phillipi*, *Syngnathus phillipi*, and *Trip-*

terygium macleayanum (Pl. 3) by A. H. Lucas; Anthropology in Australia, by A. W. Howitt; On the nomenclature of chick-embryos (Pls. 4–7). Instead of indicating the stages in the development of the chick by the number of hours or days, which is unsatisfactory, as different eggs incubated for the same length of time will frequently be found to contain embryos which have reached quite different stages of development, the stages are marked based upon the external form, and each is designated by a letter of the alphabet. On some Victorian Land Planarians, by Prof. W. B. Spencer (Pls. 11 and 12), enumerates ten species of Geoplana and describes *G. dendyi*, sp. n., and *G. frosti*, sp. n.; all the species are figured in two admirably executed coloured plates. On the movements of the heart of *Hoplocephalus superbus* in and out of the body, by Dr. McAlpine; On a Nematode from the stomach of *Hoplocephalus superbus*, and on a fluke parasitic in the respiratory and alimentary systems of the same. Neither parasites are named but the Nematode (Ascaris) is figured on pl. 8. On the presence of amœboid corpuscles in the liquid discharged from the nephridial apertures and oral papillæ of Peripatus, by A. Dendy; On the shell money of New Britain, by R. H. Rickard; On the Dukduk Association of New Britain; Notes on the miocene strata of Jemmy's Point and on the older tertiary at Bairnsdale, by J. Dennant. Some new or little known Polzyoa, by P. H. MacGillivray (Pls. 9 and 10); Notes on the marine rocks underlying Warrnambool, by G. S. Griffiths.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 29.—M. Duchartre in the chair.—Observations of the new planet M. Wolf, made at the observatory of Paris (west equatorial), by M. G. Bigourdan. From observations of comparison stars, the R.A. of the planet in question on August 27, at 12h. 20m. 33s. p.m. Paris mean time, was 22h. 41m. 24·95s., its apparent declination − 10° 25′ 51″·8, and its magnitude 12·5.—Measures of the diameter of Mars, by M. Camille Flammarion. To settle the divergence between the values of the diameters of Mars as predicted by the *Nautical Almanac*, the *Connaissance des Temps*, and Marth's "Ephémérides," measurements were taken with the 24cm. equatorial of the Juvisy observatory, resulting in values ranging from 24″·50 to 24″·91. These confirm Marth's calculations, while the other two ephemerides are about 5″ in excess, based as they are upon Leverrier's tables instead of Hartwig's.—On the solar phenomena observed at the Royal Observatory of the Roman College during the second quarter of 1892, by M. P. Tacchini.—On the bacterian origin of the bilious fever of hot countries, by M. Domingos Freire. A microscopic comparison of the germs of the yellow fever with those of the somewhat similar bilious fever of tropical countries shows that the former is due to a micrococcus, which is round, highly refractive, and easily coloured by fuchsine, methyl blue, &c., whereas the bilious fever is originated by a bacillus which the writer has succeeded in cultivating. It is about nine microns long and three broad. It is motionless, and accompanied by numerous moving spores. Each bacillus undergoes rapid segmentation into two parts, which give rise to terminal spores. It has been found possible to produce the disease in a pig by inoculation.—On the comparative assimilation of plants of the same species, developed in the sun and in the shade respectively, by M. L. Géneau de Lamarlière. A series of quantitative results, showing that under similar external conditions the decomposition of carbonic acid varies in intensity, for leaves of the same species, according to the conditions of development of these leaves; and that the leaves of a species developed in the sun, all other conditions being equal, decompose the carbonic acid of the air more energetically than those developed in the shade.—On the present eruption of Etna, by M. Wallerant. The eruption of 1892, without having the importance of that of 1865, is, from several points of view, superior to that of 1886; the flows of lava are more extended and the craters more numerous. On July 8 the volcano gave its usual warnings. Thick columns of black smoke emerged from the principal crater, and earthshocks were felt as far as Catania. On the following day the eruption began in earnest. Two openings appeared a short distance apart, one of which only gave off steam, while the other gave rise to a flow of lava which passed westwards of Monte Nero, and which has been called the western stream. It was not till after the flow had ceased that four volcanic cones arose successively from north to south at a distance of about 60 m. to the east of this cleft. Another flow of lava passed to the east of Monte Nero, and was called the eastern stream. For about a month the eruption followed its normal course; the lava continued to flow and the cones increased in height. But on August 9 important modifications took place. The ejections diminished and the explosions ceased. It was thought that the disturbance was dying out, but on the 11th such an eruption of steam took place that Etna disappeared entirely in an absolutely opaque cloud. At the same time it was found that the lava, leaving the first tracks, had taken a new path across the vineyards. In the morning of the 12th the opening of a new crater in the line of the preceding ones was found in the act of building up a cone. The previous evening the observers had passed over the same spot and had found small vents giving off vapours, but nothing to indicate the formation of a crater in so short a time. The formation of this crater was accompanied by a complete cessation of the ejections from the second volcanic cone, which had been very violent. The eruption thus seemed to have entered a new stage of development.

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THURSDAY, SEPTEMBER 15, 1892.

NEW CONTRIBUTIONS TO THE BIOLOGY OF PLANTS.

Beiträge zur Biologie der Pflanzen. Herausgegeben von Dr. Ferdinand Cohn. Band 5. Heft 3. 1892.

TO the new number of Prof. Cohn's publication Dr. Max Scholtz contributes an interesting paper on the nutation of the flower-stalk in poppies and of the terminal shoots in Virginian creeper. In both cases the nutation is dependent on the action of gravity, but has nothing to do with the weight of the bud. In the case of poppies the downward curvature of the stalk takes place with sufficient force to lift a weight equal to twice that of the flower-bud. If, however, the flower-bud be removed there is no longer any nutation; the stalk straightens itself. Vöchting had already shown that this is the case even if the amputated bud is tied on again with thread. Dr. Max Scholtz further states that if a weight three times as heavy as the bud is substituted for it, the stalk still straightens itself, and lifts up the weight. The state of the case then is this: the upper part of the flower-stalk, during a certain stage of growth, is in a high degree positively geotropic if it remains in connection with a developing flower-bud, but not otherwise. The author has further succeeded in determining the exact part of the flower-bud which governs the geotropism of the stalk. If the pistil is excised, nutation ceases, the stalk becoming negatively geotropic; but if all the other whorls of the flower are removed and the pistil left, then nutation goes on as usual. But beyond this, if the ovules are extirpated, but the wall of the ovary left standing, the nutation is stopped. Hence we arrive at the striking conclusion that the presence of developing ovules in the young ovary determines the reaction of the flower-stalk towards gravity. A certain analogy is obvious with the irritability of root-tips, investigated by Darwin. Dr. Max Scholtz's observations afford a good example of the extreme complexity of those phenomena of growth which a few years ago were thought susceptible of a simple mechanical explanation. The author thinks that the nutation is of advantage, inasmuch as the reversed position of the flower-bud allows a better access of light to the developing ovary. As is well known, the flower-stalk ceases to nod when the flower opens; in other words, as soon as the development of the ovules is completed the flower-stalk becomes as strongly negatively geotropic as it had been positively geotropic before.

Dr. Max Scholtz has made similar observations on the nodding ends of the main shoots of *Ampelopsis quinquefolia.* Here also the positive geotropism of the younger internodes only exists so long as the terminal bud is present and uninjured. Both here and in the poppies the same part of the stem which for a time shows nutation afterwards erects itself, reversing its reaction towards gravity, and also becoming for the first time positively heliotropic. This change in the mode of response to constant external influences is dictated by the embryonic organs at the growing point.

A paper by Dr. Paul Siedler on the radial sap-current in roots, consists essentially of an anatomical description of the cortex in a number of roots, and does not appear to add much to our previous knowledge. The author believes that in many cases the hypodermal layers act as a water reservoir; this is not improbable, but no experimental evidence is adduced, and the argument from structure alone is scarcely convincing.

Dr. F. Rosen writes on differences in staining between various parts of the nucleus, and between the sexual nuclei. His work is generally confirmatory of that of the zoologist Auerbach. He finds, on examining the vegetative nuclei of Scilla and Hyacinth that two kinds of nucleoli can be detected in the nucleus; the one has an affinity for red, the other for blue stains. The "erythrophilous" bodies are the true nucleoli; the "cyanophilous" granules form part of the chromatin framework. These are simply colour reactions, and are independent of the chemical composition of the stains employed.

The author's results are much more remarkable in the case of the sexual nuclei. He worked at Liliaceæ, and found that the generative nucleus of the pollen-grain takes up blue stains specially, while its vegetative nucleus is conspicuously erythrophilous. In the female organs, on the other hand, not only the nucleus of the ovum, but all the nuclei in the embryo-sac are erythrophilous, while those of the rest of the ovule give blue reactions on double staining. He believes, therefore, that he has detected a qualitative difference between the male and female nuclear substance. His statements apply to the chromatin framework of the respective nuclei.

These observations are curious, but their significance is very doubtful. The existence of a distinct male and female substance, distinguishable by reagents, is highly improbable in the light of our present knowledge of the phenomena of fertilization. It is noticeable that the author has not investigated the reaction of the sexual nuclei at the time of their fusion. Probably the differences which he has observed, like those recorded by some previous investigators, depend rather on the phase of development of the nuclei than on their sexual character.

Prof. G. Hieronymus is the author of two "Contributions to the Morphology and Biology of the Algæ." The former of these is on a curious freshwater Alga, Glaucocystis, hitherto placed among the blue-green forms. The author shows that it possesses a perfectly typical nucleus and chromatophores, and must therefore be removed from the Cyanophyceæ, and find a place among the higher Algæ, probably in the neighbourhood of the Bangiaceæ. The same applies to several other genera, which, on account of their colour, have hitherto been classed among the Cyanophyceæ.

The author's second paper is on the organization of the cells of Cyanophyceæ (Phycochromaceæ of Prof. Hieronymus). The existence both of chromatophores and nuclei in these plants has long been a subject of controversy.

As regards the former question, the author finds that the chlorophyll is contained in distinct granules, ranged in fibrillæ, which normally form a single or double layer in the peripheral protoplasm. The blue pigment, however, is dissolved in the cell-sap. He compares the green granules to the "grana" of Arthur Meyer, which, in typical chloroplastids, are the immediate seat of the colouring-matter. The colourless central portion of each "granum" may perhaps consist of a product of assimilation, such as paramylon. The fibrillæ formed by the grana are inconstant in number. They may sometimes become interspersed among the elements of the central body (nucleus ?) of the cell. The author comes to the conclusion that, while the constituent elements of chromatophores are present in these plants, they have not become associated to form definite plastids.

Passing on to the supposed nucleus of Cyanophyceæ, Prof. Hieronymus confirms the observations of previous writers as to the presence in the middle of each cell of a comparatively large body of distinctly fibrillar structure. The tangled fibril is almost certainly a single one, and is moniliform, the granulations being the staining portions. Their substance has been called by Borzi cyanophycin. The author regards them as representing the chromatin bodies of a typical nuclear fibril, though not chemically identical with them. There is no nuclear membrane, and in the older cells the fibril frequently uncoils, so that its outer windings may even reach the periphery of the cell. The author therefore proposes to term the central body an "open nucleus" as opposed to the "closed nucleus" of higher organisms. The body differs then from a typical nucleus (1) in its chemical reactions, (2) in the absence of a limiting membrane, and (3) in the absence (so far as observed) of karyokinetic phases.

The cyanophycin, under certain conditions, is said to accumulate to an enormous extent, almost filling the cell, and sometimes assuming very definite crystalline forms. The author is disposed to regard it as a reserve substance, possibly the product of the direct assimilation of atmospheric nitrogen. His observations may be taken as establishing the existence in the Cyanophyceæ of a body agreeing in many respects with the nucleus of the higher plants, but much less sharply limited off from the other cell-contents.

D. H. S.

THE GEOGRAPHY OF LABRADOR.

The Labrador Coast: a Journal of Two Summer Cruises in that Region. With Notes on its Early Discovery, on the Eskimo, on its Physical Geography, Geology, and Natural History. By Adolphus Spring Packard, M.D., Ph.D. With Maps and Illustrations. New York: N. D. C. Hodges. (London: Kegan Paul, Trench, Trübner and Co., 1891.)

A LARGE part of this excellent work has already appeared in various journals published in the United States. These contributions are not known, we fear, so widely as they deserve to be—in this country at least—and therefore Dr. Packard has been well advised to gather the scattered fragments into a homogeneous whole, making, in the truest and widest sense, a geographical study of the greatest value and interest. Chapters vii. to xvii., with the exception of Chapter xiii., are entirely new, and contain the latest results of studies which the author has made peculiarly his own, with the result that his claim that the contents of this volume represent the state of our present knowledge of the coast and interior is perfectly well founded. The outstanding feature of the work is its wide scope, appealing as it does to the geographer, the geologist, the naturalist (to use the word in its more limited sense), the botanist, the ethnologist, and the historian. Each of these will find the subject in which he is interested treated with considerable skill, and, so far as opportunity for original research allowed, with minuteness and perspicuity. One fault we have to find with the style, and that is an occasional looseness in the use of nomenclature. This distracts the reader's attention, and, until he has gone back and re-read many passages, leads him to question several statements which, when their meaning is fully grasped, are seen to be correct but badly expressed. Should a second edition of the work be called for, revision in this respect would result in a very marked improvement.

To the question as to who first sighted the inhospitable shores of Labrador, Dr. Packard has devoted considerable space, carefully examining the various claims that have been put forward. He comes to the conclusion that the honour belongs to the Norseman Biarne, or Bjarne, who, without doubt, made a landfall somewhere in North America in 990. We are strongly inclined to agree with the result arrived at on this point. The author's experiences of navigation in the region under discussion, gave him opportunities of observing and demonstrating the rate of sailing made by modern ships, and on this basis he builds up arguments which tell with considerable force against the theories advanced by Dr. Kohl and others regarding the early Scandinavian seaman, who may now be considered the almost undoubted discoverer of one of the wildest and most forbidding coasts in the world.

The derivation of the name is of interest. Coming from the Spanish and Portuguese word for a labourer, it was applied to this part of America after the visit of Cortereal in 1500, as the survivors of the voyage, on their return, held out the hope that the natives might easily be brought into a state of slavery and shipped to the Portuguese colonies to work in the fields and be, in fact, labourers for their self-appointed masters.

We have many interesting particulars regarding the ice and snow of this region. The floating blocks and bergs were carefully observed, and the conclusion, now almost universally held by geologists, confirmed that ice carried by winds and waves against the shores has had little direct influence on the configuration of the coast line. After Dr. Packard's careful investigation of this question, the statement, so frequently met with, that the sea lochs of the west coast of Scotland were formed by the action of glacial gouges, may for ever disappear from our school-books. The only instance of such glacial effect was observed at Little Mecatina Island in the Gulf of St. Lawrence, where there is no true Arctic floe-ice. An instance of the impotency of what was at one time regarded as a great eroding agency, is noted in the fact that the ship in which the author spent a considerable time amid ice-packs, presented no abrasion on her sides, the paint being as whole and unbroken when she came out of as when she entered the frozen sea. No boulders, gravels, or mud were observed on any of the icebergs examined, but as they were all of considerable age, as was indicated by the marks of frequent overturning, they had, in all probability, dropped their burdens before reaching the southern area where they were inspected.

The portions of the volume dealing with the fauna and flora, both of land and sea, are well done, and ought to prove of the utmost utility and service to naturalists. Dr. Packard has done the work of an explorer in a most masterly manner, not only setting before us the geographical skeleton of Labrador, but doing much, so far as his opportunities went—and no man's have gone farther—to clothe the bones with an array of many of the necessary facts for the building up of a complete account of the territory. To those who come after him may be left the task of filling in many details; the greater part of the work has already been accomplished, and the record is before us in these pages.

There is an excellent index, but the maps and illustrations are far from clear, and require much more distinctness than has been given them. A word of the highest praise must be accorded to the bibliography, which must have given the author a vast amount of trouble before it assumed its present admirable shape.

THE SANITARY INSTITUTE AND ITS TRANSACTIONS IN REVIEW.

The Transactions of the Sanitary Institute, 1891. Vol. XII. (London, 1892.)

THE Transactions of the Sanitary Institute cannot fail to interest a considerable section of the community now that the general principles of sanitation have become so generally appreciated, and fresh sanitary matter is so eagerly devoured—and generally assimilated—by the enlightened section of the public.

It may not be generally known that the Institute only dates its birth from the year 1876, and this fact will be the more difficult to grasp when one notes in the well-bound volume of which we write, the present scope of its transactions.

The headquarters of the Institute are in Margaret Street, W., in a building known as the Parkes' Museum, so-called to commemorate the celebrated Hygienist of that name. The whole purpose of this museum is to serve as a means of practical demonstration for the diffusion of knowledge in sanitary science, and at the present day it undoubtedly forms the best collection in Great Britain of all the various apparatus and material which can be claimed to have any connection with the public health. The value of such an institution does not need insistence upon here; but the remarks of the chairman, Sir Douglas Galton, in his recent address, may be aptly reproduced. "The evils," he says, "of our congested population meet us at every turn. If our progenitors had been properly educated in sanitary matters, our towns would not have been allowed to contain unhealthy localities; houses would not have been permitted to be built on damp unhealthy sites; buildings would not have been constructed so as to impede the circulation of air and incidence of light. Our town populations would not have been allowed to grow up herded together like the beasts of the field, without moral training or self-restraint; and our country population would not have been allowed to destroy the healthy conditions which surround them, by vitiating the pure air, and by contaminating the springs of pure water. The Sanitary Institute is thus the direct outgrowth of the public need for sanitary education!"

An excellent descriptive catalogue of the contents of the museum has recently been compiled, and those only among the 11,500 persons who have visited the building during the year ending March, 1892, who were acquainted with the museum so recently as eighteen months ago, can appreciate at its true worth the value of this addition, and can adequately testify to the improvement in the arrangement and grouping of the various sanitary appliances which has also been effected. This catalogue is bound up with the last volume of "Transactions," which, in addition, includes a lengthy list of Fellows, Members, and Associates of the Institute; a list of the contributions to the very valuable library during 1891; a very full report of valuable and able papers of hygienic interest, which have been read by Dr. Louis Parkes, Mr. Grantham, Prof. Wynter Blyth, and Sir Douglas Galton. The volume also contains a copy of the Annual Report of the Council, and a glimpse of this gives one a capital insight into the scope and work of the Institute.

In the lecture-room, in addition to papers such as those referred to above, a systematic course of lectures for sanitary officers is given throughout the year by a staff of exceptionally capable lecturers, including as it does such gentlemen as Sir Douglas Galton, Prof. Corfield, Dr. Louis Parkes, Mr. Shirley Murphy, Prof. Wynter Blyth, Prof. H. Robinson, &c. That the worth of these lectures is appreciated is sufficiently exemplified by the fact that 161 students attended them during the year; nor are they lacking attractions similar to that which insured the constant attendance of young Mr. Parker at the village choir-meetings, for they are regularly patronized by one or two female devotees of the Goddess Hygeia. There are, however, lectures provided entirely for ladies by Dr. A. T. Schofield, who treated the following subjects in his last course:—

"The Domestic Treatment of Disease."
"Microbes."
"Physical Culture."
"The Care of Old Age."

These have been well attended, and the Duchess of Albany recently presented the prizes gained by those who emerged successfully from a competitive class examination upon these subjects. The Institute holds examinations twice yearly for inspectors of nuisances and local surveyors. At these examinations 361 candidates presented themselves during the year, and 246 received "certificates of competency." Both lectures and examinations are now being provided in several large provincial towns, at a great saving of expense and trouble to aspirants for the "certificate of competency," and with the apparent effect of considerably stimulating local interest in sanitary matters. Finally, the annual Health Congress held under the auspices of the Institute is always an instructive and interesting feature in its proceedings, and is largely attended and much appreciated.

OUR BOOK SHELF.

Cooley's Cyclopædia of Practical Receipts. By W. North, M.A. Camb., F.C.S. Seventh Edition, revised and greatly enlarged. (London: J. and A. Churchill, 1892.)

THIS work is intended as a general book of reference for manufacturers, tradesmen, amateurs, and heads of families, and contains information upon all sorts of subjects, from a list of abbreviations usually employed in writing, to a description of the rare metal zirconium. Between these two articles we find notices of the methods of brewing, and the proper way of laying bricks and ventilating houses, the nature and treatment of broken wind in horses, the composition of digestive, aperient, and tonic pills, the practice of photography, the nature of infective diseases in man and beast, the destruction of caterpillars in plants, the best kind of clothes to wear, and the method of taking grease spots out of clothing. From these samples of the contents it will be seen that the book is really a most extraordinary work of reference and one which is not likely to lie idle on the shelves, but to be more or less in constant use. The work of revision has evidently been carefully done, and must have been one of no small labour, as it has been brought well up to date and many articles must be entirely new. The great practical utility of the work is shown by the large circulation it has enjoyed for many years, and the editor has done his best to maintain the well-deserved reputation of the book.

Traité Encyclopédique de Photographie. First Supplement A. Par Charles Fabre. (Gauthier-Villars et Fils, 1892.)

Many of our readers are already thoroughly acquainted with this excellent treatise which we owe to M. Fabre. In the present volume we have the first of the series of supplements which will be issued in order to keep the book well up to date. The range of progress here shown is that accomplished during the years 1889-92. The same arrangement as to numbering the paragraphs is still presented, so that it will be quite easy for those having the original volumes to refer to any section in this supplement.

The matter which is chiefly treated of here refers to the various properties and kinds of lenses and to their combinations: thus some of the most important headings that have been considerably developed may be stated as follows:—Methods of measuring focal distances, Martin's objectives, simple objectives, calculation of objectives, rapid euryscopes, Zeiss' objectives, &c. Many other new discoveries, such as Lippmann's photography in colours, have also received attention.

With these supplements this encyclopedia will be found to be greatly enhanced in value, for at the present day photography is undergoing many and rapid changes the recording of which in this form is no light task.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

The Mustakh Exploration.

Mr. Conway's march from our newly acquired district of Hunza into Baltistan (reported in the *Times*), up the Hisper glacier on one side and down the Biafo on the other to Askolay, is a splendid feat to have accomplished, a memorable achievement, and his account of it will be something to look forward to on his return to England. The total length of these two glaciers is certainly something between sixty and seventy miles measured upon the map, and over this distance the glacial forces in action are on the grandest scale. The view obtained of the Hisper glacier from the two points we ascended on either side of the Nushik La is hardly to be described, from thence the end of the Hisper glacier is not defined, and could only be indicated from the run of the spurs on the north side of the valley, and what information the guides could give. This made the total length sixty-four miles. By traversing this length of the two glaciers Mr. Conway has been able to get into ground never before visited, viz., that great ice field on the main range of the Mustakh, the full extent of which is quite unknown, and from which the Nobundi Sobundi branch of the Panmah glaciers also descends. Most interesting will it be to read the account of this glacial area from the pen of a man who knows the Alps so well, and has ascended so many of its peaks. He has gone direct and fresh from the one to the other—what an exquisite treat—and he has now seen glacial action on the vastest scale it is presented at the present time in a mountain chain out of Polar latitudes. My experience was the reverse of this, for I had not the opportunity of seeing an Alpine glacier until twenty years after I had been surveying those on the Yarkund and Hunza frontiers, and in the interval the vividness of their aspects and minor details had much faded. It is to be hoped that Mr. Conway has with him, and used, a plane table, properly projected on the four miles to the inch scale, with all the peaks fixed by the Trigonometrical Survey of India, correctly plotted on it, and will thus be enabled to add to and correct much of the previous reconnaissance work. There is no doubt, had Capt. Younghusband, who was another late explorer in this part of the world, worked with a plane table along his line of route towards Hunza, the results of his exploration would have been of tenfold value, and far more extended. The Indian Government should make it a rule that all officers permitted or selected to explore the unsurveyed territory beyond our Indian frontier, should, as a preliminary training, do a season's work plane-tabling with a Himalayan survey party. It would also be an admirable training for officers selected for the Quartermaster-General's and Intelligence Departments.

H. H. Godwin-Austen.

Nebular Spectrum of Nova Aurigæ.

Nova Aurigæ faded away so steadily in March and April as to give little promise of soon again attaining any considerable brightness. All the more startling, therefore, was Mr. Espin's announcement of Mr. Corder's discovery that it had reappeared and that he himself on August 21 had seen it as a star of the 9·2 magnitude with a monochromatic spectrum, presumably about 500 mmm. in wave-length.

Fortunately the 15-inch refractor of this Observatory is still in working order, and still more fortunately my old colleague in the observation of Nova Cygni, Mr. J. G. Lohse, is staying here. On August 25 and 26 we were able to examine the Nova with a compound prism in the Grubb stellar spectroscope. The spectrum thus seen evidently contained two bright lines, the positions of which we determined as follows:—

Chief Line: Brightness 5 *to* 10.

Date.	Wave-length.	Measures.	Observer.
Aug. 25	500·4	4	R. C.
26	500·4	3	,,
25	500·5	3	J. G. L.
26	499·9	5	,,

Second Line: Brightness 1.

Date.	Wave-length.	Measures.	Observer.
Aug. 25	495·3	2	R. C.
26	494·6	3	,,
25	495·9	3	J. G. L.
26	495·4	5	,,

From these we may derive the mean values of 500·3 and 495·3, which prove, as we think beyond doubt, that Nova Aurigæ is now mainly shining as a luminous gas nebula.

Once or twice on the 25th August, at the best moments, I had noticed feeble traces of a condensed luminosity in the spectroscope, far away on the side of less refrangibility. Our time, however, was fully occupied in observing the two brighter lines and the zinc-lead spectrum, with which we compared them, until daylight prevented further observation. On the 26th, haze and bad definition concealed everything but the chief lines, but on the very clear night of the 28th, continuing the observations alone, I examined the star with a power of 229 on the wire micrometer, and wishing to see if the spectrum had materially altered I viewed the star through an excellent direct-vision prism. In this way I at once saw a faint continuous spectrum in the green, together with a distinct line in the yellow. With the spectroscope the line was also readily perceived, but not having prepared the battery for the illuminations and comparisons, no reliable direct measures could be made. By introducing the D-line into the instrument, however, I found the stellar line to be distant from it towards the violet by a quantity equal to the interval between the nebular lines. This gives a wave-length of 580·1, which agrees closely with a bright line in Nova Cygni, in the Wolf-Rayet stars, and in γ Argûs (compare *Copernicus*, ii. p. 112, and iii. pp. 205 and 206). The continuous spectrum seemed to begin somewhat suddenly at 569·4, and faded away about 540.

On each night of observation the star was about 9·6 magnitude.
RALPH COPELAND.

Dunecht, September 6.

Daytime Seeing at the Lick Observatory.

TO some of the readers of NATURE it may be a matter of considerable surprise, as it certainly was to the writer, to find the marked superiority which a small telescope sometimes offers over a large one for the observation of solar prominences.

On numerous occasions during the last year, while adjusting the large star spectroscope of this observatory to the 36-inch refractor, I have improved the opportunity to examine the limb of the sun with a Rowland grating. At no time, however, has it been possible to get any definition in prominence. With the 6-inch equatorial, on the contrary, one gets very fair definition, even in the middle of the day; while in the early morning, from six to eight o'clock, the seeing is, as a rule, superb. Thinking these differences might possibly vanish if the larger glass were used earlier in the morning, I have recently made a systematic comparison of the three equatorials, viz., the 6-inch, the 12-inch, and the 36-inch. For this purpose a small grating spectroscope (kindly loaned by the Chabot Observatory) was used with an adapter which fitted all three telescopes, so that the whole comparison could be made in a few minutes. The third and fourth orders of a 14438-line grating were employed.

The result of a half-dozen mornings' observations was that no detail whatever could be made out with the 36-inch, however much care one might use in the adjustment of his instrument. One could form a rough estimate of the height and general outline of the prominence, but nothing more.

On the 12-inch the general features were considerably more distinct, but the fine delicate tracings of the various parts of the prominence could be seen only with the 6-inch. The capping down of the 36-inch and the 12-inch failed utterly, as might have been expected, to improve the definition on any occasion.

The large image of the sun given by the 36-inch (six inches in diameter), combined with the poor seeing during the daytime, makes the instrument act, *for sunspot observation*, very much like an integrating spectroscope. The lines affected by absorption, in spots of any considerable size, can be picked out readily, but one finds it quite impossible to compare the absorption of the nucleus with that of the penumbra. These three telescopes each give images of nearly the same brightness, and one does not find much, if any, difference in the amount of dispersed light in the field.

During the dry season, the sides of the cañons surrounding this observatory become intensely hot, and highly heated currents of air are continually rising from them. So that, probably, the conditions which make the order of efficiency of these telescopes in the daytime just the reverse of what it is at night, are purely local.
HENRY CREW.

Lick Observatory, August 19.

Ridgway on the Humming-birds.

MR. ROBERT RIDGWAY, curator of the bird department of the U. S. National Museum, has just published (in separate form), in the report of that institution for 1890, his monograph of the Trochili. Coming from such an authority and essaying to deal with such an interesting group, this work will undoubtedly command the attention of ornithologists, and be studied with the care it no doubt merits. It makes its appearance in octavo form, of some 130 pages, being illustrated by 46 full-page plates, and has besides a number of cuts in the text. The plates give us many species of humming-birds and their nests; they being all of the "electro-process" variety, and chiefly copied from Gould's princely work upon the Trochili. As is usually the case, most of the figures given have suffered by the method of reproduction employed, and not being coloured, they offer us, at the best, with but a poor idea of the "living gems" they are supposed to portray. With more or less thoroughness Mr. Ridgway has touched upon the early history and the literature of his subject; upon the geographical distribution of the various species; upon their number, which he makes out to be about 500; upon their natural history in general (treated in various brief sections); and there are descriptions of their external characters and a short note upon a few of their internal ones. It is with the statements made in the latter that I chiefly propose to deal in the present connection, and, aware as I am of our author's knowledge of the literature of what we may call the natural history and classification of the humming-birds, as contra-distinguished from their morphology and affinities, I must confess my surprise at his ignorance of the latter part of his subject. Mr. Ridgway remarks (p. 290) that "the humming-birds possess nothing absolutely peculiar, although certain features, shared by other groups of birds, notably the swifts (*Micropodidæ*), are developed to an extreme degree; as, for example, the very high keel to the sternum and consequent excessive development of the pectoral muscles, the short armwing (humerus) and extremely long handwing (manus), and minute feet with relatively large, strongly curved, and sharp claws. The humming birds and swifts further agree in numerous anatomical characters, and there can be no doubt that they are more closely related to each other than are either to any other group of birds. In fact, except in the shape of the bill and structure of the bones of the face, the humming-birds and swifts present no definite differences of osteological structure." As the present writer has probably published double the number of accurate figures illustrating the *entire anatomy* of a great many species of humming-birds as compared with any other worker; and, further, has published correct accounts of the same to the extent exceeding that of any three living avian-morphologists, and those figures and descriptions having been very extensively accepted as correct, perhaps our author will consider me competent to criticize the statement which I have just quoted from his work. Notwithstanding the extensive and painstaking labour I have given to such matters, I reckon it but as little when compared with the opinions given us by Huxley and Kitchen Parker in the same premises.

As long ago as 1867 (P. Z. S., p. 456), Huxley expressed the view that "in their cranial characters the swifts are far more closely allied with the swallows than with any of the Desmognathous birds, the swift presenting but a very slight modification of the true Passerine type exhibited by the swallow;" and Parker has said in *The Zoologist* for March, 1889 (p. 2), "I agree with my friend, Dr. Shufeldt, that the 'swallow and the swift are near akin.' My opinion is not the simple judgment it was forty years ago. I have observed a good many things since then in the structure of birds of all sorts." Both of these high opinions I can confirm, and in support of them, and as contradicting every statement almost that my good friend and ornithologist, Mr. Ridgway, has made in his work touching the structure of swifts and humming-birds, I would invite his attention to many comparative figures and accounts published by me in the Proceedings of the Zoological Society of London at various times, and also to an extensive paper of mine which appeared in the Journal of the Linnean Society of London, in 1888 or 1889, having been read at the Society by W. K. Parker, F.R.S., who accepted, in the main, what I had stated in it. Therein I anatomically compare the *entire* structure of *every* species of United States swallow with the corresponding structures in a great many swifts and a great many humming birds, and I would invite Mr. Ridgway's attention to the synoptical comparisons given on pages 376-378, especially as off-setting his statement, as quoted, that "in fact, except in the shape of the bill and structure of the bones of the face, the humming-birds and swifts present no definite differences of osteological structure." And, unless as a true systemist and believer in *colours and measurements* rather than in structural characters as determining the real affinities of vertebrate forms, I would finally invite his consideration of my comparative figures and description of the humerus of a swallow, a swift, and a humming-bird given in the Proc. Zool. Soc., Lond., for 1887 (pp. 501-503), and then ask his candid opinion upon the question whether the humerus of a swift is morphologically more like that of a humming bird than it is like that of a swallow, and the humerus is one of the bones that has been so frequently dragged into the discussion to prove cypselo-trochiline affinities.

Washington, D.C., July 24. R. W. SHUFELDT.

"The Limits of Animal Intelligence."

IT is with much pleasure that I have read Prof. Lloyd Morgan's letter, wherein he tells us that "the power of cognizing relations, reflection, and introspection" appears to him to mark a "new departure" in the ascending scale of psychical activities. His term, "feeling of awareness of certain relationships," is new to me, however, and seems to demand a further distinction. I am generally aware, in a vague way, of what I may be doing—that is to say I have a certain consciousness of it. But every now and then I find that I have done, without consciousness, things which I could not have done without the exercise of my sensitive faculty, or without the guidance of bodily movement, by that faculty.

I most cordially concur in the Professor's desire that the investigations to which he refers should be accompanied by "calm, temperate, and impartial discussion" founded on observation and experiment. I, as well as Prof. Lloyd Morgan, have long carried on such observations and experiments, and it is on them that are founded what I have written on "Our lower and higher mental powers" in chapters xiv. and xv. of my book[1] "On Truth." To them I may perhaps be permitted to direct the Professor's attention, since he is engaged with a work on Comparative Psychology. I have as little wish to dogmatize as has Prof. Lloyd Morgan, and am perfectly ready and willing to recognize the true rationality of any animal whenever I obtain evidence thereof. My assertion of the exclusive rationality of man has been represented as due to other causes than what I deem to be the weight of scientific evidence. Such is an utter mistake. To admit that animals possess intellect would neither be repugnant to my feelings nor conflict with any other of my convictions. As yet I hold all animals to be irrational, simply because I have met with, in them, nothing inexplicable by what the Professor calls "simple awareness" and what I call related feelings. All prejudice should indeed be eliminated from scientific inquiry, but such can hardly be the case with any one who starts from an *a priori* "standpoint of evolution" in the sense that he holds discontinuities in nature—real "new departures"—to be impossible.

The Professor says: "In conclusion I must be allowed to say that the phrases 'differences in kind' and 'differences in degree' savour somewhat of mere Academic discussion." Nevertheless there really are differences of kind, and such differences are themselves different in kind from mere differences of degree. He would, of course, allow that the difference between the Binomial Theorem and the Bouquet of Chateâu d'Yquem is one "of kind," as also that between solving the *Pons asinorum* and riding *Equus asinus*. I am convinced there are also psychical differences of kind, and I have become so convinced (in spite of having started with a contrary opinion) through experiments and observations.

ST. GEORGE MIVART.

Hurstcote, September 6.

The Theory of the Telephone.

IN a paper in this month's *Phil. Mag.* I ventured to publish an explanation of the fact that in the telephone it is necessary for the diaphragm to be situated in a permanent magnetic field.

Since then my attention has been called to a paper (*The Electrician*, Feb. 11, 1887, p. 302) by Mr. Oliver Heaviside, in which he has given a very complete theory of the question at issue.

I hasten to express my regret that I had not met with this paper in time.

FRED. T. TROUTON.

Physical Laboratory, Trinity College, Dublin.

Crater-like Depressions in Glaciers.

IN the note on the St. Gervais Catastrophe (NATURE of September 1) I read that a crater-like depression had been found in the Tête Rousse Glacier. As such depressions are quite exceptional occurrences in European glaciers, it may be of interest to note that I found several holes of a similar kind in the great Tasman Glacier in New Zealand. One of these reached—like the Tête Rousse one—apparently to the bottom, the others, which were from 150 feet to 300 feet deep, did not. The walls of these "craters" were not vertical but above only 45°, the incline increasing below. Till now I have considered these funnel-shaped depressions as immensely widened "Glaciermills," but after the observation on the Tête Rousse it seems to me not improbable that these holes on the Tasman were also originally caused by subglacial collapse.

R. VON LENDENFELD.

CHOLERA: PREVENTION AND VACCINATION.

THE epidemic of cholera with which this country is threatened seems likely to test very completely the means for the prevention of its spread which have been devised as the result of the extended experience of some of the ablest hygienists. The working out of the history of an epidemic disorder must necessarily be extended over a prolonged period of time, for it is dependent on the researches not only of the clinical observer, but of the pathologist and the bacteriologist and of those who devote themselves to the difficult study of the march of epidemics. The development of such researches is closely allied to the advance of science generally, and although there is at any one period a large admixture of "fashion" in the opinions held by experts, yet in time this fades, and the truth is established. It cannot be too clearly stated that the best measures for the prevention of an epidemic disorder can only be devised when we possess an accurate knowledge of the infective agent of the disease (bacillus or not, as the case may be), of its life-history, of its varying degrees of virulence, and the mode of entrance into the body, of the conditions under which it multiplies, and of the changes which it produces in the human body.

In the case of cholera our knowledge is not yet complete. Clinical observers many years ago showed that the infective agent was present in the peculiar evacuations passed by the cholera patient, and it was further found that these evacuations were the means of contaminating the water supply of a locality, and so causing the spread of the disease in the community. These two facts have been established beyond doubt. The exact nature of the living infective agent is not, however, so well ascertained. It was in 1884 that Koch described the *Vibrio Choleræ Asiaticæ* as constantly present in the evacuations of cholera patients, but he was unable to prove that it was the cause of the disease, owing to the insusceptibility of animals to cholera. It was shown that the vibrio was present also in the intestinal walls, but it was never found in the organs of the body. The work of subsequent observers has brought forward fresh facts of importance. It is now known that the cholera vibrio (the comma bacillus) is allied to several other forms which are pathogenic, and that there are several varieties (perhaps twelve) which have been described by Dr. Cunningham. The cholera vibrio is also known to vary greatly in virulence; it is so susceptible to its surroundings that a slight change will diminish its activity and certain conditions will increase its virulence. One method of increasing its activity is by passing it through a series of animals (guinea-pigs); after a certain time the vibrio becomes extremely active and will kill animals very quickly, it is said in even eight hours. With these virulent cultures symptoms have been produced in animals closely resembling those of Asiatic cholera; in the exudation of liquid into the intestines, in the cramps, in the suppression of urine, and in the collapse so well known in the disease in man. There are therefore certain grounds for considering Koch's vibrio as the cause of Asiatic cholera. But the question is not settled: it is not as clear that the vibrio is the cause of Asiatic cholera as that the bacillus anthracis is the cause of anthrax. The probabilities are greatly in favour of this presumption, but the slight doubt existing must be borne in mind when the question of vaccination for cholera is to be considered practically. The doubt that rests on the vibrio as the cause of cholera may be stated shortly in the fact of the existence of allied forms of bacteria which produce similar symptoms, such as the vibrio Metschnikovi. We know, too, that in man cholera is produced by what is drunk, and yet animals fed with the vibrio do not get any of the symptoms which have been mentioned, unless they are "prepared" by a course of treatment, either by neutralizing the acidity of the contents of the stomach, and subsequently giving a dose of opium to quiet the intestines, or by giving a dose of alcohol with the vibrio. This vibrio cannot get through the acid stomach alive. The answer to the question as to how it gets through the human stomach rests partly in the fact that in the early part of digestion, or in between meals, the stomach is not very acid, and so there may not be a sufficient degree of acidity to kill the vibrio. Such remarks would, however, equally apply to the guinea-pig stomach; and the question as to why in animals the swallowed vibrio does not produce choleraic symptoms unless the animal is "prepared" is still unanswered; although such animal may be killed by an injection of the virulent preparation of the vibrio into its veins. This difficult point can only be settled by investigations along new lines, probably chiefly chemical.

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[1] Referred to on p. 266 of NATURE for July 21, 1892.

One point suggested by the investigations of the cholera vibrio which we surmised previously to 1884, is that the infective agent in the disease not only primarily attacks the intestines, but grows there, producing the symptoms of the disease by its chemical products, without itself entering the blood stream This has an important bearing on the question of vaccination for cholera. The experimental investigation of vaccination against infective disorders is a product of modern bacteriological research. It is too long a question to deal with in a short article; it is sufficient to say that it is based on the fact that a mild form of the disease may be produced in an animal, which will then be protected from the virulent disease. As in Pasteur's historical experiments, the attenuated or weakened anthrax bacilli were found, when injected into a sheep, to prevent the animal dying when it received a dose of virulent bacilli, which would undoubtedly kill it in ordinary circumstances. This vaccination, when put into practice, was found to diminish the amount of natural anthrax in sheep in France. Similar results have been obtained with the vibrio of Asiatic cholera by some of Koch's assistants, and latterly by M. Haffkine, in the Institut Pasteur in Paris. Haffkine attenuated the virulent vibrio by means of a current of air and other means, and obtained a culture which did not kill animals, but protected them against a subsequent injection of the virulent vibrio itself. The vaccine was also injected into human beings (who lent themselves for experiment), and was found to produce a local inflammation associated with some degree of fever, all the symptoms passing away in a short period. It is probable that the majority of "vaccines" would produce these symptoms. It is, however, a great step to apply vaccination experiments in animals to human beings when the etiology of the particular disease is not completely worked out, and there is, perhaps, too great a tendency in modern research to extend "vaccination" experiments in infective diseases before a correct knowledge of the mode of action of the infective agent has been obtained. It has been pointed out that doubt rests on the vibrio choleræ Asiaticæ as the true cause of Asiatic cholera. It may be; but to impartial observers it has not been proved to be. Vaccination for cholera on a large scale would therefore at present be a mistake, as it might possibly lead to carelessness in the carrying out of better tried preventive measures, which depend not only upon the State but also on the private individual. As a promising field of research, it might be applied to man, since the vaccination itself appears to do no harm. But it requires a long time to decide so difficult a question, and in the meantime the community is face to face with cholera. It is therefore more practical to consider preventive measures than vaccination.

Preventive measures against cholera are of two kinds, those taken by the State to prevent the importation of the disease from cholera-stricken districts, and those which ought to be practised by individuals when cholera is prevalent in the community. Both sets of measures depend upon two well-ascertained facts, viz. that each cholera patient acts as a focus of the disease, and that the disease is spread by the evacuations contaminating the water supply. The State can prevent the importation of cholera by quarantine, but this method has been abandoned in England for many good and obvious reasons, and another substituted for it which is considered as likely to be more effectual, but which can only be applied with an efficiently working sanitary organization. In this country we get cholera by ships bringing cholera-stricken people, who are landed. At all the ports, in times of cholera, the ships are boarded by the medical officer, and if any cases of the disease are present they are taken to isolation hospitals, whilst those who are well are allowed to land after leaving their names and destinations. The medical officer of their district is communicated with, and keeps them under surveillance for some days. The cholera ship is moored to a special buoy and disinfected. If no cases of cholera are present on the ship, the passengers and crew are allowed to land, the taking of the names and addresses being left to the discretion of the medical officer who inspects them. It is possible that no better method than this could have been devised, which, with the least inconvenience to the individual, would at the same time keep under surveillance all the imported cases of cholera, and thus check the spread of the disease. It is evident that such a method is quite impracticable without efficient sanitary officers; it would, for example, be useless in a country like Turkey, where the system of quarantine and sanitary cordons exists as in most other European countries. And in our country the application of this method of isolation and surveillance is surrounded by practical difficulties and dangers which may become serious, and which are in any case worthy of discussion. It is quite possible that the medical officer of the port will have too much to do. At present the cholera epidemic at the Continental ports, even in Hamburg, appears to be diminishing, and it may disappear when the cold weather comes, to reappear with unabated virulence next spring. As this is probable, no decrease of vigilance of medical inspection is permissible during the winter months; and it is to be hoped that the sense of security felt by the community at the diminution of cholera on the appearance of cold weather will not extend to the medical officers in whose keeping the general health of the nation lies. If, next spring, cholera becomes disseminated along the Channel on our opposite shore, the medical officers of our ports may be exercised to their utmost in providing accommodation for patients on cholera-stricken ships, and some, apparently well, may proceed to their homes and develop the disease before the medical officer of their district has been advised of their advent. This is, no doubt, a danger which might come even from a ship which has been passed by the port medical officer with a clean bill of health.

The personal measures to be taken when cholera is in our midst are important, but need only be mentioned. Since cholera spreads by the evacuations, these must be disinfected with hydrochloric acid, carbolic acid, or corrosive sublimate as soon as they are passed; and all linen soiled by a cholera patient must be rigidly disinfected. Since the water supply may become contaminated, all water used for drinking, washing utensils, &c., must be boiled, and all articles of food, such as milk, likely to be contaminated with unboiled water, should also be subjected to the heat of boiling water. When these and similar measures for personal protection are rigidly observed, it is not too much to say that cholera will not spread.

THE PLANET VENUS

M. E. L. TROUVELOT has published a most important and extensive paper on some observations of the planets Venus and Mercury, which for many years past have been occupying his attention. The physical features of the other planets have been treated on previous occasions in like manner, and have extended our knowledge very considerably, so that the reader of this work will be sure to find something really new in the great number of observations that are here recorded. Up to the month of April, 1882, the observations were made at Cambridge, United States; but since then Meudon has been the seat of operations; the air at the latter place did not prove so pure as that in the States, and the horizon not being so open, the number of observations of course was somewhat reduced.

In the work which we have before us the author divides this subject up into nine sections, and we cannot do better than treat of each of them in turn, commencing with the visibility of Venus to the naked eye in full daylight. The best way is, he says, to use the telescope as a pointer, directing it to her by means of the circles; by then looking along the telescope tube he has been able to see her at every point of her orbit, when her angular distance from the sun towards inferior conjunction was not less than 10°, and also towards superior conjunction when she was not less than 5°. Her visibility depended to some extent on the phase she represented, for it is known that the eye can distinguish more easily a disc small and distant than a comparatively larger and nearer crescent. At Cambridge it seems to have been more or less the rule, while at Meudon it was the exception, to see Venus in the daytime, the atmospheric conditions at the latter place being comparatively very bad.

With regard to the general aspect of Venus nothing very striking has been noticed; the part of the limb turned towards the sun, as recorded by other observers, always appeared more brilliant than the more central portions extending towards the terminator. Sometimes the limb was not so bright as usual, being observed to be "dull and without brilliancy," one very noticeable time occurring on April 15, 1878.

Under favourable conditions, whitish and greyish spots can be seen on the surface of Venus, which, at any time, are very difficult to observe. These different-tinted spots give, according to M. Trouvelot, indications of being at different levels. The whitish spots, situated near the terminator, produce on it slight deformations, and seem to so alter it as to suggest that these spots are at a higher level than the other parts. The greyish spots, on the other hand, when situated in about the same positions, also deform the terminator to a small extent, but in an opposite way to those just mentioned, suggesting that these spots lie at a lower level than the parts near them. These two kinds of spots have another peculiarity which has been particularly noticed, and that is their size; the white ones seem to assume a round or slightly oval form, and are nearly always small, but the grey spots are generally of an elongated shape, and are of very large proportions, forming sometimes straight bands. The interval between the appearance and disappearance of these spots is not long; in their formation they are analogous, as M. Trouvelot says, "avec ces taches diffuses des couches nuageuses continues de notre atmosphère précèdent les pluies, et qu'un simple jeu de lumière fait naître ou disparaître." Their contours are always very vague, the whites being a little less brilliant, and the greys a little less dark.

One of the largest spots that has been diligently observed was that which appeared on the 3rd September, 1876. Its size, as will be seen from the figure, was, comparatively speaking, enormous, occupying nearly a third of the illuminated visible surface. At its north and south extremities it was separated from the terminator by a large white band, the north one being considerably larger than the southern one. Up to the 10th of the same month this spot was still visible, but after that date no trace of it at all could be found. Curiously enough, on February 13th, 1891, another large grey spot (Fig. 2), bordered with white, made its appearance, and was very similar to the one we have just mentioned, both with regard to its position and form—indeed, the resemblance was so striking that the spots were considered the same.

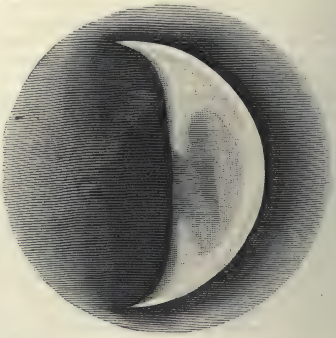
FIG. 1.—Showing the large spot on September 3, 1876.

Why it should have disappeared so soon in 1876, and become visible again in 1891, is a mystery which is hard to fathom.

Perhaps one of the most interesting features visible on the surface of Venus are the two snow caps (Figs. 3 and 4) at the extremities of her poles. These spots, as M. Trouvelot says, surpass in brilliancy and importance all that he has ever observed. In 1877, on November 13th, a white spot was seen at the north limit of Venus; its brilliancy attracted considerable attention, resembling very much those situated on Mars. On the following day, another spot, also very striking and of the same character, diametrically opposed, was observed. The question then arose as to the cause of these spots, and we may here quote an entry that was written in the observer's book on the 17th of the same month:—"Est-ce que Vénus aurait des taches blanches semblables aux taches polaires de Mars?" The seeing of these spots was by no means a difficult task, and it seemed certain that if

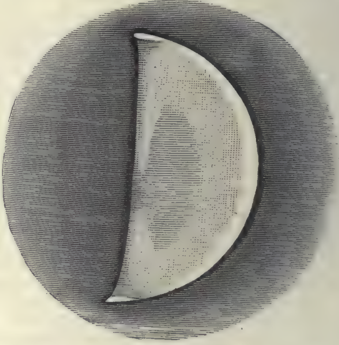
FIG. 2.—Large spot visible on February 18, 1891.

they were snow caps as suggested, perhaps they had been previously observed. This was the case. On June 9 and 17, July 20, August 1 and 27, 1876, and February 5, 1877, observations of these spots had been recorded in the notebook, but owing to their not having attracted very great attention at the time, they were regarded as ordinary spots. That they are analogous to the white spots on Mars is now undoubted: they have the form of a uniform white segment of a circle, which, when seen edgeways, appear as simple lines; they are always exactly 180° apart; sometimes only one is seen because the other is not lighted up by the sun; they are always approximately near the terminator, and seem to oscillate backwards and forwards, balanced, so to speak, around the axis of the planet; and, lastly, they are of a permanent nature, their disappearances being due not to their annihilation, but simply to the fact that they cannot be seen when receiving no light upon them. One main feature in which they differ from the spots on Mars is that they neither increase nor decrease with the seasons, at any rate to a sufficient extent to be sensibly noticed.

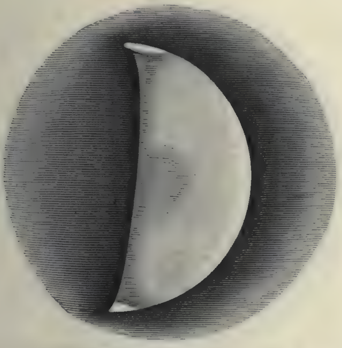
FIG. 3.—The snow caps, February 20, 1891, 10h. 45m.

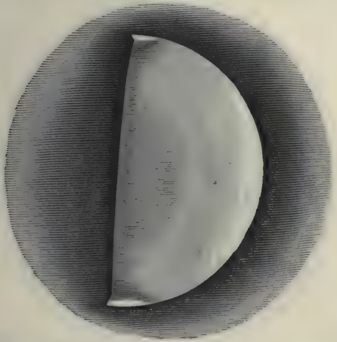
FIG. 4.—The snow caps, February 25, 1891, 10h. 15m.

When Venus is in a favourable position for observation many details on these spots have been recorded. M. Trouvelot mentions here some bright spots (Figs. 5 and 6), which seem to be very numerous, and resemble the bright specks which are seen on the terminator of the moon, "sinon qu'elles sont plus brillantes, surtout sur leur bord interne, et qu'au lieu de petits cratères, elles sont entièrement couvertes et hérissées de pics et d'aiguilles, qui, parfois, réfléchissent la lumière avec une si grande intensité, que ce bord apparaît tout constellé d'étoiles alignées comme les grains d'un collier de pierres précieuses, sans quelques irrégularités dans cet alignement." The whole appearance seems to suggest that the spots are at a higher level than the contiguous parts of the planet situated at the edge. This idea is also further borne out when the phase of the planet is a small crescent, for then much more of the polar cap is found to be visible than should be the case if the form of the phase was an exact crescent. In many cases a penumbra has distinctly been seen, and in one of them it was so strong and distinct on that part of the terminator lying between the two polar caps, that it lasted for a month, the spots remaining clear and brilliant throughout their entire length. Ever since the year 1700, observers of Venus have remarked these two spots that occupy the polar regions. La Hire and Derham, observing the inequalities of the surface at the extremities of the crescent, believed that they could be produced by mountains higher than those on the moon. Bianchini at Rome, Schroeter, Gruithuisen, and several others, all have reported the existence of such markings, but they were never led to conclude that they were snow caps analogous to those on Mars.

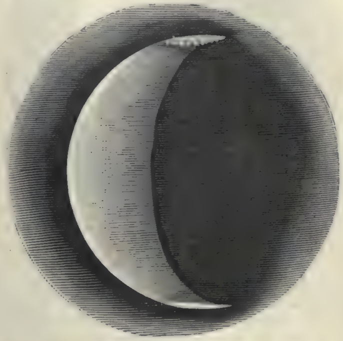
FIG. 5.—Details on the snow caps, January 19, 1878.

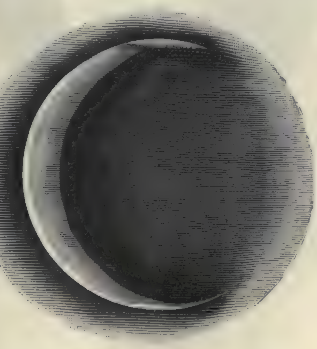
FIG. 6.—The snow caps, February 5, 1878.

To obtain a general idea of the ruggedness and smoothness of the planet's surface, the terminator has helped to considerably distinguish the high and low elevations and depressions respectively. The surface of Venus from such observations as these has been found to be considerably studded not only with small, but with great differences of configuration, the terminator varying greatly in many phases of the planet. M. Trouvelot's results show that these deformations become most apparent when Venus is at her greatest eastern and western elongations. Sometimes one half of the terminator is seen concave, while at the same time the other is convex (Fig. 7); small indentations at the horns (Fig. 8) also seem to be of common occurrence, and occasionally the curve of the terminator is perfect, no trace of any irregularity being noticed. Not only then does the terminator change in form, but changes are found to occur very rapidly in intervals of only a few hours. To take one case out of many, we may quote the instance recorded in 1881 on February 5 at 2 p.m. (Figs. 9 and 10). At this time the terminator appeared as a straight line showing Venus then in apparent quadrature, but at 5h. 43m. this line was quite gibbous, and its curve regular. A very important point about the repetitions of the same deformations is that they do not occur at exactly the same time each day, but appear to change the hour of observation, "the periodicity of these phenomena, if periodicity there is, not being exactly twenty-four hours."

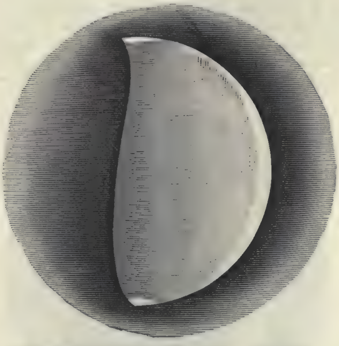

Fig. 7.—Showing irregularity of Terminator, November 23, 1877.

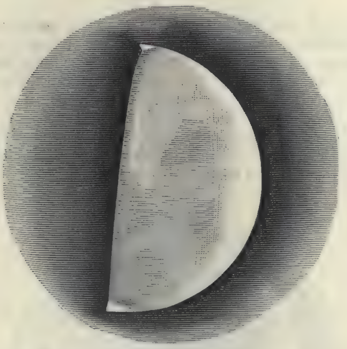

Fig 8.—Showing indentations at the horns, February 28, 1891.

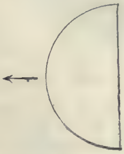

Fig. 9.—February 5, 2h.

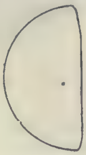

Fig. 10.—February 5, 5h. 43m.

From a long series of observations, the most striking irregularities were found at the extremities of the terminator close to the edge of the pole caps, where deep niches were often recorded. These indentations were noticed to be generally of different sizes and shapes, sometimes the north one being larger than the southern one, and *vicê versâ*. They also underwent very rapid changes even in the space of a few hours, a case occurring on September 27, 1876 (Fig. 11). "At one time the extremity of one of the horns would be more or less truncated, when the other would be sharp, and some hours later the reverse would be the case, that which was sharp being truncated, and that which was truncated being sharp." M. Trouvelot concludes that his observations bring out a very important fact—"qu'il a une relation très étroite entre les déformations les plus importants subies par le terminateur et par les cornes, et les taches polaires de la planète"

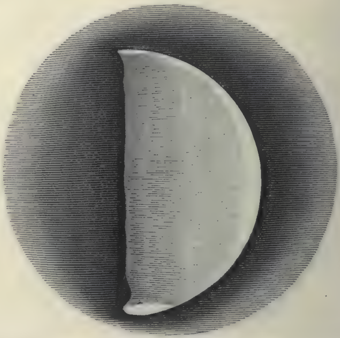

Fig. 11.—Showing the shape of the horns, September 27, 1876.

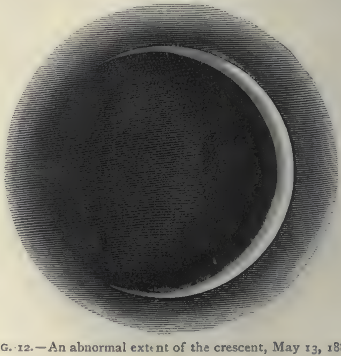

Fig. 12.—An abnormal extent of the crescent, May 13, 1881.

When Venus approaches inferior conjunction with the sun, its crescent gradually diminishes until the illuminated surface is turned exactly away from us. Just before this position is reached, the crescent has been found to present many curious features. The most prominent of them is that this fine crescent is sometimes observed to extend to a greater angular extent than 180° (Fig. 12), 260° of the limb of the planet having once been recorded. Sometimes, by adopting special precautions, the whole circumference has been observed, the obscured disc being completely surrounded by a pale and thin luminous ring. This, as M. Trouvelot says, is of very rare occurrence, for it has happened that although the greatest precautions have been taken, no trace of the planet could be found.

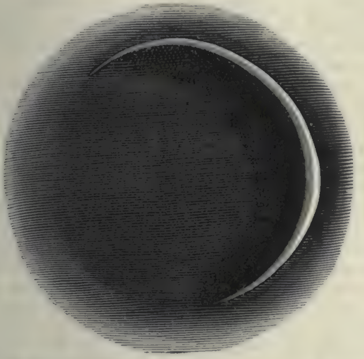

FIG. 13.—Showing the bulging out of the crescent as seen on February 24, 1878.

When the crescent is extremely fine, great irregularities have been noticed to mar the continuity of its curve; they differ also not only at different but at the same conjunctions according as the planet is to the east or west of the sun.

Another fact that has been observed relates to the bulging out of the planet (Figs. 13 and 14) at some parts of its visible limb. This was especially noticed in the month of February, 1878; while the crescent was being looked at, the south-south-east portion seemed to suddenly appear thicker than the remaining part. In fact, the observer in the first instance thought it might have been due to some optical defect in the instrument; but subsequent observation showed that this was not the case, a real change of form having taken place. Two days later this deformation was still more noticeable, the thickness of the visible section being about double what it would have been had it been in its normal condition.

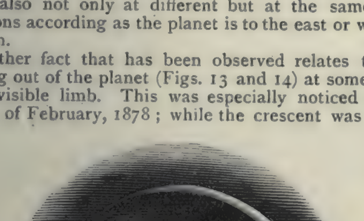

FIG. 14.—The crescent as seen on February 26, 1878.

Perhaps one of the most important points referred to in this work is the determination of the period of rotation by means of the spots. This question of rotation is one that has baffled many observers, for the difficulty that has presented itself lies not only in the proper motions of the spots themselves, but in the identification of the same spots after brief periods of time. Glancing over some of the periods already obtained, we find that Schroeter deduced from his observations a rotation of about 24h., basing his value on the movement of a small isolated spot situated in one of the horns. Fritsch's value of 23h. 22m., and P. de Vico's 23h. 21m. 21s., are both also of about the same length. From observations by D. Cassini and F. Bianchini, we have a very wide deviation, the periods of rotation being reckoned in days, the former arriving at a value of 23 days, and the latter at a somewhat larger one of 24 days 8 hours. Coming now to Schiaparelli's value of 225 days, we have here altogether a new departure, the planet rotating on its axis in the same time as it revolves round the sun.

With such values as these it will be at once seen that there is something radically wrong with the spots or their positions on the planet's surface; in some cases, of course, there might have been instances of mistaken identity, but with such an observer as Schiaparelli, who very definitely settles upon a 225 daily period obtained from direct observation, it is hard to conceive that any such sources of error would not have been remarked.

The observations which we have now before us bear out Schroeter's view of a short rotation, Prof. Trouvelot telling us that they were made during the years 1876–78 under exceptionally good conditions. One very interesting point which is of great importance is the fact that these observations were made at the same period, "souvent dans la même journée, sous un ciel également propice et précisément sur la même point de la planète."

The value nearest to 24 hours that Prof. Trouvelot obtained was 23h. 49m. 28s., and in giving this period he remarks that it is founded on the supposition that the spot had no proper motion. In referring to the period deduced by Schiaparelli he says, "La cause probable de l'erreur de M. Schiaparelli semble résulter de ce fait que les taches *h* et *k*, qui ont servi de base à ses conclusions, faisaient partie de la tache polaire méridionale qui, étant située centralement sur l'axe de rotation de la planète, semble rester stationnaire, comme cela se voit sur la tache polaire de Mars, quand elle se trouve réduite à de faibles dimensions." Taking into account many of the general features visible on the planet's surface, such as the rapid deformations of the horns and of the terminator, all these point to short periods of rotation, which, as Prof. Trouvelot points out, is "inconciliable avec la période de rotation, si lente et si inattendue, déduite par l'éminent astronome de Milan."

In concluding our remarks we cannot help mentioning the very complete way in which Prof. Trouvelot has taken into account the prior work in this interesting field of inquiry.

W. J. L.

NOTES.

THE Iron and Steel Institute will meet at Liverpool from Tuesday, September 20, to Friday, the 23rd. Sir Frederick Abel will preside. The following papers will probably be read and discussed:—(Tuesday) on the condensation of ammonia from blast furnaces, by Sir L. Bell, F.R.S.; on alloys of chrome and iron, by R. A. Hadfield; on the Liverpool overhead railway, by J. H. Greathead: (Wednesday) on the engineering laboratories in Liverpool, by Prof. H. S. Hele-Shaw; on the Siemens-Martin process at Witkowitz, Austria, by P. Kupelwieser; on failures in the necks of chilled rolls, by C. A. Winder: (Thursday) on a new process for the elimination of sulphur, by E. Saniter; on the elimination of sulphur from iron, by J. E. Stead. On Tuesday evening the members and their friends will dine together, and on Wednesday evening there will be a conversazione in the Walker Art Galleries, offered by the Mayor of Liverpool and Mrs. James De Bels Adam. A part of each of the first three days will be devoted to the inspection of various works, and on Friday there will be excursions, one party going to Chester, another to Stoke-on-Trent. If a sufficient number of names are given in, there will also be an excursion to the new Water Supply of Liverpool at Lake Vyrnwy.

THE Sanitary Institute, whose Transactions for 1891 are reviewed elsewhere, is holding its thirteenth annual Congress this week at Portsmouth. About 400 members are attending the meetings. The proceedings began on Monday, when Sir Charles Cameron, the president, delivered an address on "The Victorian Era, the Age of Sanitation." He presented a very interesting sketch of the good results which have sprung from the improved sanitary methods of modern times. The frightful mortality of London and other cities in the last century he described as an evil due to insanitary conditions. By the earlier part of the nineteenth century the grosser defects had been remedied, and the death-rate had been greatly reduced. For about half a century no further improvement took place, but with the passing of the Public Health Acts of 1872 and 1875 an era of active sanitation ensued, with the result that the death-rate fell sensibly in nearly all the towns. Sir Charles urged that the success of past sanitary work ought to encourage us to redouble our exertions to reduce the urban death-rate to at least that of the most healthy of our towns.

THE International Congress of Orientalists finished its scientific labours on Friday last, and every one connected with it agreed that the meetings had been most successful. On Saturday a good many members visited Oxford, while others went to Cambridge. Both parties were cordially received by representatives of the Universities. A meeting held on Monday for the despatch of business brought the proceedings to a close. At this meeting a number of reports and resolutions were read by the secretary, Prof. Rhys Davids. The first resolution proceeded from the Semitic section, and recommended that the Government should be urged to subsidize the study of modern Arabic. The Assyrian and Babylonian sub-section, and also the Egyptian section, passed a resolution in favour of holding at least one combined meeting of the Assyrian and Egyptian sections. The anthropological section expressed its sense of the political as well as the scientific importance of the anthropometric investigations now being conducted in Bengal. The same section also expressed its view of the desirability of forming a collection of Oriental folk-lore on a scientific basis. In the Semitic section a committee had been formed, consisting of men of science from different countries, for the purpose of preparing an Arabic-Mahomedan encyclopædia. At the head of this committee was Prof. Robertson Smith. The Australasian section desired to express its sense of the immediate necessity of pressing forward research into the physical character, languages, arts, customs, and religion of New Guinea. Count Angelo de Gubernatis moved a resolution, which was seconded and carried, in favour of the establishment of an International Institute of Orientalists, with its headquarters in London. It was decided that the next meeting of the Congress should be held at Geneva in 1894—the meeting to be postponed until the following year if circumstances should render such postponement necessary or desirable. On the motion of Prof. Ascoli, seconded by Prof. Drouil, a vote of thanks to the President was cordially passed. In the evening a dinner was given at the Hôtel Métropole by the Organizing Committee to the foreign members.

THE Perthshire Society of Natural Science is one of the most enterprising of British local societies, and we are glad to hear that it is about to give fresh proof of its energy by extending its museum. This includes two excellent collections—the one a general or index collection, intended, by means of carefully-selected specimens, to act as a guide to the study of natural science; the other, a Perthshire collection, intended to give a complete view of the fauna, flora, and geology of the district. These collections have grown so rapidly that there is not now sufficient accommodation for them. It is proposed that the deficiency shall be met by the erection of a supplementary museum hall and gallery, in which the Perthshire collection will be displayed, while the present building will be devoted chiefly to the index collection.

AN improved spherometer, constructed in Zeiss' optical laboratory at Jena after Prof. Abbe's design, is described in this month's *Zeitschrift für Instrumentenkunde*. It is made to measure down to 0·001 mm. To eliminate errors due to the indefinite nature of the base circumscribed by the three legs of the ordinary spherometer, the surface to be measured is laid upon a circular ring, and the contact rod is screwed up from below. This ring has two sharp concentric edges 0·5 mm. apart, the one for convex and the other for concave surfaces, made of hard steel and ground down to the same level, giving a combination which is less liable to be damaged than a single edge. The ring rests without fastening on a perforated horizontal disc provided with a cylindrical projection which just fits into a hollow in the bottom of the ring. The latter is thus free from strain, and can be easily replaced by another of greater or less diameter. The height of the graduated contact rod is read by a micrometer microscope. The first reading is taken when the contact piece touches a plate of plane-polished glass laid over the ring. The plate is then replaced by the surface to be measured, and its radius of curvature calculated by the usual formula.

ON Thursday, the 8th inst., the Cunard Royal Mail twin screw steamer *Campania* was launched from the yard of the Fairfield Engineering and Shipbuilding Company. This is the largest ship afloat, the dimensions being: length, 620 feet; breadth, 65 feet 3 inches; and depth, 43 feet. It exceeds the *City of Paris* or *City of New York* by 60 feet in length and 2 feet 3 inches in breadth. The launch of the *Campania* was an ideal one. Although the launching weight of the ship was 9000 tons, there seemed to be not the slightest hitch. At 2.45 p.m. Lady Burns performed the launching ceremony. The huge ship immediately began to move and slowly travelled down the ways, entering the water amidst the loud cheers of some 80,000 people. The Fairfield Company have every reason to be proud of this feat. Not only was the weight to be launched unprecedented, but, the Clyde at this point being very narrow, the big ship had to be stopped immediately she was afloat owing to her great length. The *Campania* will be driven by two sets of triple expansion engines, each set having five cylinders arranged to drive a three-throw crank shaft, the cranks being set at the angle of 120 degrees from each other; there are two high-pressure cylinders, one intermediate, and two low pressure cylinders, the high-pressure being placed above the low-pressure cylinders. These engines together will indicate about 25,000 horse-power. Steam will be generated by twelve large double-ended boilers with ninety-six furnaces. An auxiliary single-ended boiler is used for supplying the steam for the electric lighting and secondary purposes throughout the ship. The main boilers are arranged in two groups, each group having a funnel 19 feet in diameter. It is expected that the speed attained will reach twenty-two knots on the trial, and it is hoped, when the engines have settled down to their work, that this speed may be attained on the Atlantic.

The weather has remained very unsettled during the past week, owing to the complex distribution of barometric pressure, there being during the first part of the time low-pressure areas over the northern parts of the kingdom, while an anticyclone lay over France and the Bay of Biscay. These conditions caused a considerable amount of rain, especially in the north and west, although in the southern and eastern parts of the country, the weather was fair, with mist or fog in places. During this period the maximum temperatures rarely exceeded 65° in any part; on Sunday and Monday, however, the anticyclone moved eastwards, and gave place to large depressions from the westwards, rain being general, except in the south-east of England, where the maximum temperatures rose to 70° and upwards, and similarly high readings occurred in the midland and southern districts. On Tuesday a cyclonic disturbance was crossing Scotland, and heavy rain was reported there and in the north-west of Ireland. The Weather Report for the week ending the 10th instant shows that the mean temperature was below the average over the whole of the United Kingdom, and although fairly high day temperatures were registered, the night readings were below 40° generally, and in the east of Scotland they fell to within a degree of the freezing point. The rainfall for the same period was generally less than the normal, and in the south-west of England there was still a deficiency of ·8 inches since the beginning of the year.

In his report on the rain, river, and evaporation observations, made in New South Wales during 1890, Mr. Russell states that the widespread interest in rainfall records is rapidly adding to the number of observers, which now amounts to 1088. The year was conspicuous for abundant rainfall, causing heavy floods in the river Darling, far exceeding those of which there are complete accounts. The average rainfall for the whole colony was 32·73 inches, being 32·6 per cent. greater than the average for the previous sixteen years. The report contains the results of interesting experiments on the effect of forests and elevation on the amount of the fall. At Dinby, which is situated in a densely timbered country, the amount was 35·89 inches, while the mean of nine of the nearest stations gave 38·92 inches. As an instance of the effect of elevation, the average rainfall at Wallongong, half a mile from the sea, at an elevation of 67 feet, is 38·84 inches, while at Cordeaux River, six miles from the sea, it is 55·53 inches.

The Annual Report of the Acting British Resident of Perak for the year 1891 contains monthly summaries of meteorological observations at nine stations, and a chart showing the comparative range of monthly rainfall during the years 1888-91 at Taiping. The highest recorded temperature in the shade was 97° at Kuala Kangsar and Parit Buntar in the months of March and April respectively; the lowest 62°, in February, at Taiping and Salama. The only solar thermometer, that in Taiping, registered 121° in March and May. The rainfall varied from 85·6 inches at Teluk Anson to 183 inches at Topah. It is well distributed throughout the year, the driest months being May to July.

A most unusual phenomenon was seen in the Maltese Islands on July 21, when a thunderstorm raged for twelve hours, and deposited three inches of rain. According to the *Mediterranean Naturalist*, it is fifty-five years since rain fell in Malta in the month of July.

In the annual report of the British Museum (Natural History) reference is made to two "principal events" relating to the conservation and arrangement of the Zoological collections. The first is the enlargement of the building which contains the collections of specimens preserved in spirits. An enlargement had been rendered necessary mainly by the reception of the *Challenger* collections, which proved to be more extensive than had been anticipated. The addition to the building is already roofed in, and may be ready for occupation within the next twelve months. The other matter of exceptional importance is the arrangement of the collection of birds' eggs. In the old Museum this collection consisted of a small number of specimens of more or less great historical value, and of an imperfect series of deteriorated specimens of the British species, which were exhibited in three table-cases. The first important addition was received in the "Gould" collections, purchased in 1881; other miscellaneous series followed; and, finally, the magnificent donations of Europo-Asiatic species by Messrs. Godman, Salvin, and Seebohm, and of Indian eggs by Mr. A. O. Hume, added so much to the number of specimens, and imparted such a great value to this collection, that its systematic arrangement could be no longer delayed. At the same time the formation of a perfect series of British birds' eggs for exhibition and consultation by the public had become more and more urgent. A requisite grant having been made by the Lords Commissioners of the Treasury, Mr. Seebohm undertook the work of arranging both the general and the British series; and in the course of this year he has made such progress that about 24,000 specimens, belonging to fifteen families, are catalogued and beautifully arranged in thirteen cabinets, and that the British series can probably be opened to the public in the present year.

The authorities of the French laboratory of physiological psychology have sent a circular to painters, sculptors, and designers, asking them to answer various questions as to their visual memory of colours and forms. Some replies have already been received, and one of the things noted in several of them is that the writers are able, when they see a painting, to perceive at a glance whether the artist has a good visual memory or not.

Mr. M. A. Dumont contributes to the current number of the *Revue Scientifique* an interesting paper on the history of the population in a small rural commune, Saint-Germain-des-Vaux. He has closely examined the communal registers from the early part of the eighteenth century until the present day. It is curious to see how the tendencies not only of the commune, but of its individual families, with regard to the increase or decrease of population, correspond to those of the French nation as a whole.

The *Kew Bulletin* for September opens with a section on Caraguatá fibres. Samples of the Caraguatá plant were obtained through the Foreign Office from Dr. Stewart, British Consul at Asuncion, and submitted to Mr. J. G. Baker, by whom the plant is here described. The number also contains Decas III. of "Decades Kewenses," "New Orchids: Decade 3," and sections on Lagos palm oil and some vanillas of commerce.

We learn from the *Kew Bulletin* that a handbook of Australian fungi has been prepared by Dr. M. C. Cooke, Mycologist in the Herbarium of the Royal Gardens, Kew, and published under the authority of the several Governments of the Australian Colonies. It contains a full description of all the fungi so far known to occur in Australia and Tasmania, number 2084 species. All the genera are illustrated by 36 plates, 20 of which are coloured.

Mr. Vice-Consul Scratchley, of Philippeville, Algeria, has presented to the Museum of the Royal Gardens, Kew, an axe, scraper, and knife, such as are used in the collection of cork in Algeria. The *Kew Bulletin* says that the Museum contains numerous illustrations of the applications of cork, the bark of the cork oak (*Quercus Suber*, L.). The tree grows in Spain, Italy, South of France, and Algeria, and the first crop of cork is taken from the trunk as it stands, at the age of about thirty years, and afterwards at intervals of from six to ten years. The later crops furnish the best bark, which is used for bottle corks and similar purposes.

In his annual report to the Secretary of the Science and Art Department, Dr. V. Ball, Director of the Science and Art Museum, Dublin, says that throughout the past year Major McEniry was continuously engaged in the rearrangement of the Royal Irish Academy collections. Mr. W.F. Wakeman rendered valuable assistance in preparing descriptive lists of the "Crannog finds," and Mr. George Coffey made a catalogue of the Irish coins. Both have been printed, and will serve as valuable records, for future reference, of the present condition and contents of these two branches of the collection. They will, moreover, afford useful material in the preparation of a contemplated handbook to the collection, which now claims attention, but for which some special arrangement will have to be made. In the same report Dr. Ball notes that under the efficient management of Mr. Moore the Royal Botanic Gardens, Glasnevin, maintained during the year their now well-established position as one of the principal centres of scientific horticulture in the United Kingdom. The continued and widespread interest in the operations carried on there is amply shown by the generous support which plant growers still afford by their contributions of novelties.

Mr. E. S. Morse, Director of the Peabody Academy of Science, has been investigating the older forms of terra-cotta roofing tiles, and presents the results of his inquiry in the latest Bulletin of the Essex Institute, Salem. His paper is a valuable contribution to the study of a very interesting subject. The earliest known form of tile consists of two elements—a wide tile (tegula) either square or rectangular, more or less curved in section, and a narrow semi-cylindrical tile (imbrex), usually slightly tapering at one end to fit into the wider opening of the one adjoining. The tegula is placed on the roof, concave face upwards, and the imbrex, placed concave face downwards, covers the lateral joint between two adjacent tegulæ. Tiles of this kind covered the roof of the very ancient temple of Hera at Olympia, the form being identical with that of tiles still used in the remote East. Afterwards the form was modified in Greece and Italy. In one or other of its varieties, this tile—which has been called by Graeber the normal tile—is found all over Asia, in Asia Minor, and in the countries bordering the Mediterranean. The well-known pantile combines the two elements, imbrex and tegula, in one piece. It originated in Belgium or Holland, and is used mainly in those countries, in Scandinavia,, and to some extent in England. The flat tile is simply a shingle in terra-cotta, and has no genetic relation to the other forms of tiles. It is used in Germany, Austria, Poland, Switzerland, France, and England. Mr. Morse's paper is well illustrated, and contains a map showing the geographical distribution of these three types of tile.

Mr. Walter Hough contributes to the report of the U.S. National Museum for 1890, just issued, a very good paper on the methods of fire-making. Having in a previous paper discussed the apparatus of fire-making, he now deals with the handling of the apparatus. All mechanical methods of generating fire take advantage of the law that motion, apparently destroyed by friction, is converted into heat. These methods can be grouped under three classes:—(1) wood friction, (2) percussion of minerals, (3) compression of air. Three other methods exhaust the entire range of usages in fire-making, and, with one exception, they are perhaps recent. These may be arranged in the following classes:—(4) chemical, (5) optical, (6) electrical. These exhibit the action of friction in its highest manifestations. Each method Mr. Hough examines in turn. His exposition is concise and clear, and carefully illustrated.

Several sponge deposits have been discovered at a distance of about 150 metres from the western shore of the island of Pantelleria (depth about thirty metres). Five Greek vessels, with two divers, obtained in three days about twenty-five quintali of sponges of the finest quality.

Two papers which will be included in the forthcoming Macleay Memorial Volume were read at the meeting of the Linnean Society of New South Wales on July 27. One of them, by Prof. F. W. Hutton, is on the Pliocene Mollusca of New Zealand. It gives a complete list of the Mollusca hitherto met with in the Pliocene fossiliferous beds of New Zealand. Such beds have been found only in the southern and eastern parts of the North Island. About 64 per cent. of the Pliocene Mollusca are also found in Miocene rocks, but the Pliocene fauna is well characterized firstly by the presence of the genera *Trophon*, *Columbella*, *Turricula*, and *Mytilicarda*, by the absence of certain genera present in Miocene strata, and thirdly by the small size of sundry species common to both formations. From the recent fauna, that of the Pliocene is distinguished by the presence of from 23–37 per cent. of extinct species, and of a number of genera no representatives of which up to the present time are known to inhabit New Zealand seas. The Pliocene fauna, therefore, seems to be the remains of an earlier fauna disappearing rapidly before the conquering host of the recent fauna, which had invaded New Zealand some time previously. The other paper is by Prof. W. Baldwin Spencer, and offers contributions to our knowledge of Ceratodus, with special reference to the blood-vessels.

At the same meeting of the Linnean Society of New South Wales, Mr. Rainbow exhibited the two sexes of an undescribed Sydney spider (*Nephila* sp.), the webs of which were said to be strong enough to catch male birds.

Mr. A. C. Gatto writes in the *Mediterranean Naturalist* that the pretty moth *Deiopeia pulchella*, Beis, has occurred this year in Malta in unusual abundance. On August 10, when his note was written, and for a fortnight before, it was the commonest moth to be seen on the wing in the island. He does not remember ever to have had occasion to record such extraordinary numbers of any butterfly or moth. This remarkable abundance he supposes to be due to the fact that the rains of the late spring caused an overgrowth of the *Heliotropium europæum*, on which the Deiopeia feeds. The moth is white, with small red and black spots on the forewings, and with white underwings bordered with black. It is subject to much variation, sometimes the black dottings predominating, sometimes the red ones; but it is a very characteristic form and easily distinguished.

A new edition of Mr. Alfred Gibson's well-known "Agricultural Chemistry" has been issued by Messrs. Routledge and Sons. The book was originally issued more than thirty years ago, and there has been a steady demand for it ever since. In preparing the present edition the author has had the help of his nephew, Mr. A. E. Gibson, in making such changes as the advance of agricultural chemistry has rendered necessary.

Messrs. Macmillan and Co. have issued a new edition of Mr. W. H. H. Hudson's "Arithmetic for Schools." The work has been enlarged and very carefully revised.

The University College of North Wales, Bangor, has issued the prospectus of the work to be done by its agricultural department during the session 1892–93. The fund for the promotion of agricultural education amounted, in the session 1891–92, to £1900, and was derived partly from a grant by the Board of

Agriculture, partly from private subscriptions, and partly from grants by the County Councils of Anglesey, Carnarvonshire, and Montgomeryshire. A considerable sum was also contributed locally to meet the expenses of field experiments, dairy demonstrations, and Extension lectures. Two things are aimed at in connection with the College scheme of agricultural education:—(1) To provide at the College as complete a training in agriculture and the sciences related to agriculture as can be obtained at any of the recognized Agricultural Colleges, and especially to provide such a training as would be suitable for land agents, farmers, bailiffs, and young men who intend emigrating with a view to farming in one of the colonies. (2) To make the College a centre of agricultural education for North Wales, and to organize in the six northern counties of the Principality, in connection with the College, a system of instruction to meet the special wants of each agricultural district, and supply a graduated system whereby pupils may pass from the School to the College. Several local landowners and farmers have enabled the College to make arrangements by which farms in the neighbourhood of Bangor can be used by the lecturer in agriculture and the members of his classes for the purpose of practical instruction.

In a paper on the Ainos of Yezo, contributed to the latest report of the U.S. National Museum, Mr. Romyn Hitchcock refers to the arrow poisons used by the Ainos. The method of preparing these poisons has been revealed to only one traveller, Dr. B. Scheube, who believes his information to be correct, as the accounts obtained from different localities entirely agree. His account is as follows:—The young side roots of *Aconitum Japonicum* are usually gathered in summer and dried in the shade until autumn. The roots which contain active poison become softer, while the others grow harder; apparently a process of fermentation takes place. The former, after the removal of the skin, are rubbed between two stones to a pasty mass. There is no further preparation. This material is either spread directly upon the arrowheads or preserved. The poison maintains its activity for five months. Dr. Scheube adds that in every village the poison is prepared only by a few old men, not because the process of preparation is unknown to the others, but because these men have had experience in its production. Prayers, magic formulas, and the like are not recited during the preparation. The activity of the poison is tested by a portion being placed on the tongue. To ensure its action each arrow receives portions from three different preparations. Dr. Stuart Eldridge has made some chemical and physiological investigations of this poison, which confirm the supposition that aconite is its active ingredient. But Dr. Eldridge declares that the pulp prepared as described is mixed with other ingredients, which he has been unable to identify, but which are probably inert, and the resulting mass is buried for a time in the earth. On removal from the earth the poison, he says, appears as a stiff, dark, reddish-brown paste, through which fragments of woody fibre are distributed; and the poison, when applied to the arrow, is mixed with a certain proportion of animal fat. Mr. Hitchcock secured two specimens of the poison, which are in the form of hard lumps. Specimens of the plant from which the poison is obtained were collected by Mr. T. Holm, and determined by him as *Aconitum Japonicum*. In some parts of the country it grows in great abundance, and the fine purple flowers are very pleasant to the eye.

In their very interesting account of various plants growing in and through the shells of marine mollusca (noticed by us in Nature) Bornet and Flahault called attention to some fungoid-like hyphæ, which were recorded under the names of Ostracoblabe and Lithopythium, but in the absence of any fructification or of very definite characters, their position was not more accurately determined. Dr. Bornet, on looking over the fourth part of the Berichte der deutschen botanischen Gesellschaft was struck by the resemblance of *Lithopythium gangliiforme*, B. and F., to the deeper hyphæ of *Verrucaria caliseda* as represented by M. Bachmann in figures 3 and 4 of plate ix. accompanying his memoir (Die Beziehung der Kalkflechten zu ihre Substrat) and it occurred to him that the hyphæ found perforating the marine shells might be those of lichens. To verify such an idea, Dr. Bornet spent some time at Croisic towards the close of the summer of 1891. Here, of the shells gathered at low-water mark or not uncovered at each tide, a large number had the calcareous portions traversed by filaments of *O. implexa*. Sometimes these filaments were solitary, at other times and more frequently they were accompanied by one or more of the perforating Algæ (Gomontia, Ostreobium, Mastigocoleus, Hyella), but nothing either in or externally seemed to indicate that they were the hyphæ of a Lichen. When the shells were gathered off the rocks at a height at which they were frequently out of the water, a large number were found to present discoloured patches covered with dark depressed spots formed by the spermogonia and apothecia of a Verrucaria. The shells of *Purpura lapillus* with the mollusc, or serving as a home for some hermit crab, were the more frequently attacked. Some shells of Patella and Balanus were also attacked. When thin sections were made, perpendicular to the surface of the shell, the outer border appeared granular and was nearly opaque, the hyphæ and the alga condensed in the gonidial layer, having caused the semicrystalline shell structure to disappear, leaving it in a powdery state. But deeper in that portion of the shell which in part preserved its transparency the filaments could be seen perforating it to a considerable extent, and these presented all the characters of those described by Bornet and Flahault as belonging to *O. implexa*, with the sole exception that the fusiform dilatations were not observed. On decalcification the gonidia were found to be mostly supplied by *Mastigocoleus testarum*, some few by *Hyella cæspitosa*. Towards the margin they were reduced to the condition of isolated cells, but deeper down, the long branches of the thallus were found little altered and most easily recognisable, presenting a most favourable example of the connection existing between the gonidial stages of the filamentous algæ. M. l'Abbé Hue recognized the lichen of *Purpura lapillus* as *Verrucaria consequens* (Nyl). It will be noted that the hyphæ of this Verrucaria are capable of living isolated, not except under certain conditions uniting with the algal forms, these latter requiring the presence of the open air from time to time, so that the lichen stage is not developed on the shells always submerged. *Lithopythiuim gangliiforme*, though carefully looked for, was not met with, but its history, when known, will no doubt be equally interesting.

Dr. A. B. Griffiths writes to us to explain, in answer to a criticism which appeared in the recent review of his book, "The Physiology of the Invertebrata," that it is extremely difficult to determine in what state of combination uric acid exists in the urine of invertebrates. He, however, considers it more than probable that both potassium and lithium occur in the urine of some of these animals.

The additions to the Zoological Society's Gardens during the past week include two Philantomba Antelopes (*Cephalophus maxwelli*) from Sierra Leone, presented by Mr. P. Lemberg; two yellow-bellied Liothrix (*Liothrix luteus*) from China, presented by Mr. J. Holmes; four Poë Honey Eaters (*Prosthemadera novæ-zealandiæ*) from New Zealand, presented by Capt. Edgar J. Evans, R.M.S. *Tainui*; a Little Grebe (*Tachybaptes fluviatilis*), British, presented by Mr. Thomas Riley; a Hoopoe (*Upupa epops*), a Greater-spotted Woodpecker (*Dendrocopus major*), twelve Fire-bellied Toads (*Bombinator igneus*), European, purchased.

OUR ASTRONOMICAL COLUMN.

DISCOVERY OF A NEW SATELLITE TO JUPITER.—A telegram from New York announces that Prof. Barnard, of the Lick Observatory, Mount Hamilton, California, has discovered a fifth satellite to Jupiter. It is of the thirteenth magnitude, with a period of revolution round the primary of 17h. 36m., its distance from the centre of the planet being 112,400 miles.

VARIATION OF LATITUDE.—Dr. Chandler, in the *Astronomical Journal* No. 273, concludes his series of very important articles on the discussion of observations with regard to the cause of the variation of latitude. The material he has used comprises more than thirty-three thousand observations, made in seventeen observatories with twenty-one different instruments, as many as nine distinct methods of observation having been employed. Out of the forty-five series in which these observations are arranged, only three show results which do not harmonize with the general law as stated in the fifth article (see "Astronomical Notes," NATURE, vol. xlvi. p. 211). The values of the three come out negative, and as they are numerically small, they can be with justice discarded, for, as Dr. Chandler says, "a mere rejection of a single discordant equation (out of a total number of 427), in two cases, and of two in the third, would convert them into positive values." Instead, then, of the ratio of the difference of the two moments of inertia to the principal one being 1°·18, and perfectly uniform as given by theory, observation suggests the value 0°·85 (for 1875), the motion not being uniform but subject to a slow retardation which "in its turn is not uniform." The first difference was soon found by Prof. Newcomb to be due to a defect in the theory, an allowance of the earth's elasticity not having been taken sufficiently into account, but with regard to the second he urges an objection "on the ground of dynamic impossibility." In such a discussion as this of course an outside opinion cannot be counted of much value, but we quite agree with Dr. Chandler that if an observed fact disagrees with the result of theory, and a flaw is found in the theory, there can be no reason why another observed fact of equal weight, but also in discord with theory, should be regarded as "impossible."

BRIGHT STREAKS ON THE FULL MOON.—In *Astronomische Nachrichten*, No. 3111, Prof. Pickering gives a brief condensed account of the investigation that has been carried out at Arequipa with regard to the systems of bright streaks, especially round prominent craters, that are visible on our satellite at the period of the second and third quarters. The instrument employed was the 13-inch, and the magnification ranged from 450 to 1120 diameters. The chief results noted were:—(1) That the streaks of the systems round many of the large craters are not oriented to the centre of the prime crater, but towards other craters whose dimensions are considerably smaller. (2) These minute craters are extremely brilliant, and rarely exceed one mile in diameter. (3) Some streaks are found to lie across or upon ridges; these are very seldom connected with small craters. (4) In the case of Copernicus, streaks are found to start from craterlets inside the rim and low up the inner side of the walls, and down the other side. The rim of Tycho also contains similar craterlets, but the streaks do not extend very far. (5) A difference in colour was noticed between the streaks systems of Copernicus, Kepler, and Aristarchus, and those of Tycho, the last-mentioned being considered whiter than the others. (6) There are no very long streaks; their general length may be reckoned from ten to fifty miles. What have been previously taken for long streaks are found, by minute observation, to be simply a series of these smaller ones connecting up, apparently, many small craters. That extending from the regions of Tycho across the Mare Serenitatis is so constructed. In seeking an explanation to account for the origin of these bright streaks, Prof. Pickering suggests that if, for example, the craterlets on the rim of Tycho were constantly emitting large quantities of gas or steam, which in other regions was being absorbed, "we should have a wind uniformly blowing away from that summit in all directions." Should other craterlets in the vicinity "give out gases mixed with any fine white powder, such as pumice, this powder would be carried away from Tycho, forming streaks." This hypothesis, besides explaining the presence of the streaks themselves, satisfies very well the fact that they can only be seen after and before the first and last quarter of the moon phase, for it is only at this time that the contrast would be best seen.

NOVA AURIGÆ.—On the receipt of Mr. H. Corder's information relative to the brightening of Nova Aurigæ, Mr. Espin made an examination of its light on August 21, and found that the star was of the 9·2 magnitude. Since then Prof. Küstner, has also observed it (August 31, 11m.·4 Bonn mean time), and reckoned it to be as bright as on March 21 last. The Astronomer Royal's photographic determination, made on August 30, accounts it to be about the 12th magnitude.

NEW OBSERVATORIES.—Mount Monnier, in the Maritime Alps, has been visited by M. Bischoffsheim and M. Perrotin, with the object of setting up a new observatory. It is proposed to raise on the summit (2800 metres altitude) an observatory, the work of which will be commenced next April. *L'Astronomie* for September also informs us that the Astronomical Observatory of Abbas-Touman (lat. N. 41° 46′, long. E. Paris, 40° 32′) will be ready for work in a few weeks. The observatory is already installed with a refractor of 29 inches, and as it is situated at a considerable height, it will be used for those special stellar studies which are difficult at Pulkowa, Moscow, and Kazan.

SOLAR OBSERVATIONS AT ROME.—Prof. Tacchini, in the July number of *Memorie della Società degli Spettroscopisti Italiani*, gives in tabulated form the results of the observations made at the Royal College with reference to the prominences seen at the sun's limb during the months of April, May, and June. In the table showing the frequency of these phenomena for every 10° of latitude north and south, we find that the numbers for the three months respectively were 83, 97, and 147 for the north, and 75, 110, and 183 for the south latitudes. This shows an excess of 41 for the south, the zone in which they mostly occurred being (–50°–60°): the zone of greatest frequency for the north was (+60°+70°). The frequency at the equator was comparatively small, 26 and 23 being the numbers recorded for the zone of 10° each side.

GEOGRAPHICAL NOTES.

A REUTER telegram from St. John's, dated September 11, says that the steamer *Kite*, which left that port three months ago to relieve the Peary Expedition, has just arrived there, after having successfully accomplished its object. Lieutenant Peary, who is an engineer in the United States Navy, left America early last year in command of a small expedition consisting of only five men, the object of which was to spend one or more winters in Greenland for the purpose of scientific observation, and to make an attempt to reach the North Pole across the interior of Greenland. The commander of the expedition was accompanied in this arduous enterprise by his young wife. The winter quarters of the party were fixed at McCormick Bay, whence Lieutenant Peary travelled 1300 miles northwards over the inland ice, which he found to be in a favourable condition for his journey. After making some important discoveries, the explorer returned to the quarters at McCormick's Bay, where, according to previous arrangements, he awaited the arrival of the relief expedition. Lieutenant Peary, his wife, and his five men are all well. Lieutenant Peary's great sledge journey commenced on May 15 last on the true ice cap of Greenland at the head of McCormick's Bay, and at an elevation of four thousand feet. The explorer, who took with him only one man and fourteen dogs to draw the sledge, passed along the edge of the Humboldt Glacier and then across the feeder basins of the St. George's and Osborne Glacier system. On June 26 he reached the 82nd parallel. Here the coast trended to the north-east, and then east, and finally compelled the explorer to pursue a south-easterly course. After four days' march, during which the coast still stretched south-east and east, Lieutenant Peary reached the head of a great bay in latitude 81° 37′, and longitude 34°. This was on July 4, and in honour of the day he named this opening Independence Bay. The glacier terminating on its shores he called the Academy Glacier. The land here was of a red-brown colour and free from snow, and flowers, insects, and musk oxen were abundant; while hares, foxes, and ptarmigan were also seen. On July 9 Lieutenant Peary and his companion started on their return journey, taking a more inland course, and in seven days' time they were travelling over soft snow on the interior plateau, at an elevation of 8000 feet.

The explorer then again descended to the coast, covering thirty miles a day. He met the *Kite*, with the relief party, on August 4, near the head of McCormick's Bay, having completed his original programme to the very letter. The geographical discoveries made by the expedition include the tracing of the Greenland coasts above the 79th parallel, the termination of the continental ice-cap below Victoria Inlet, and the existence of glaciers on all the northern fiords. Many valuable tidal and meteorological observations were also obtained, as well as a quantity of material for the ethnological study of the northern Eskimo, including specimens of their costumes, tents, and sledges. The expedition brings home, besides a number of photographs of natives and of Arctic scenery, a large collection of the flora and fauna of the high latitudes visited.

THE four Dundee whaling vessels, whose intended voyage to the Antarctic seas has been already referred to in these notes, sailed from Dundee last week. Three of the vessels carry surgeons who have been specially instructed in making meteorological and biological observations. They are fully equipped with appliances for collecting specimens of every kind. The more strictly geographical conditions will be observed by the captains, who have been supplied with additional instruments to enable them to lay down their track with a greater degree of accuracy than would be necessary in ordinary circumstances. Their long Arctic experience fits them for navigating the ice-hampered waters of the South and for comparing the conditions found there with those of the better-known North Polar zone.

THE railway from Jaffa to Jerusalem is now practically completed, and will be opened for traffic before the end of this month. Recent events in Russia have caused a great increase in the Jewish population of Jerusalem, leading to the extension of the city beyond the walls. The railway will do much to promote the prosperity of Palestine and will probably be largely utilized.

THE Gilbert Islands, in the Central Pacific, have been definitely brought under British protection. The group is bisected by the equator, and forms the central link in the long chain of coral and volcanic islands which stretches from the northern to the southern tropic between the meridians of 160° and 180° E. The Marshall Islands, which are the most northerly of this chain, are under German control.

THE Proceedings of the Royal Geographical Society for September publishes an interesting account of a journey in Sikkim undertaken by Mr. C. White and Mr. Hoffman in July 1891, with the purpose of exploring and photographing the surroundings of Kanchinjinga. The travellers crossed by the Zeumtso La pass into the Tremu Valley, the magnificent glacier in which was visited for the first time by Europeans. The main glacier—fifteen miles long—is joined by the union of six smaller glaciers, and several others were observed which could not be approached. The Tremu Valley was proved to be only a fortnight's journey from Darjiling, a fact which makes the almost entire ignorance of the existence of glaciers in it very remarkable.

IN the course of his travels into the interior of Iceland (*Petermann's Mitteilungen*, vol. 38), Th. Thoroddsen discovered an unknown lake in the unexplored region of Vatna-Jökull. "The greatest part of the western edge of the Vatna-Jökull is formed by a mighty glacier, whose margin stretches with faint curvature towards the southern horizon. The mountain chains which reach the glacier are powerless to influence its shape. We were surprised by the discovery of a very long lake, stretching from the margin of the glacier close to us towards the south-west as far as the eye could see, and filling up the valley between us and a parallel mountain chain. The narrow lake is of a milk-white colour, formed as it is by glacier ice. I named it Langisjor. The glacier reaches with its steep flank to the north end of the lake, and as it is riddled with clefts it is impossible to ride round on this side. The landscape round the lake is of magnificent beauty, only vegetation is quite absent. The greenish-white lake is surrounded by red and yellow tuff hills, with innumerable fantastic points and summits. On the other side of the chain which terminates the lake in the south stretches an extensive flat plateau, in which glitters a large watercourse, probably the Skapta, and far to the south are seen some great lava streams, dating probably from the 1783 eruption."

INTERNATIONAL CONGRESS OF PHYSIOLOGISTS.

THE second International Congress of Physiologists, which took place at Liège on August 29, 30, and 31, was attended by more than 100 physiologists, including among others:—Prof. F. Holmgren (Upsala), President of the Congress, Profs. Hensen, Hürthle, Kühne, Rosenthal, Cybulski, Kronecker, Miescher, Fredericq, Héger, Heymans, Arloing, Chauveau, Dastre, Gréhant, Hédon, Langlois, Laulanié, Morat, Wertheimer, Hamburger, Grigorescu, Wedensky, and the following English members: Profs. Foster, Burdon Sanderson, Schäfer, Allen, Gotch, Halliburton, Horsley, Purser, Waymouth Reid, Stirling, Waller, Drs. Adami, Beevor, Paton, Martin, Mott, Pye-Smith, Sherrington, Starling, Shore, Sims Woodhead; Messrs. Bayliss, Burch, and Parsons.

The work of the Congress was carried on in the Institutes of Zoology and Physiology, these institutions being placed at the disposal of the members by the kind courtesy of the two directing professors, whilst in addition the whole arrangements were excellently organized through the energy of the Professor of Physiology, Prof. Léon Fredericq.

The work of each day was so arranged that the mornings only need be devoted to the formal hearing of communications in the large lecture hall of the Zoological Institute, and the afternoons were thus left entirely free for informal meetings in the Physiological Institute, when demonstrations of special interest were shown in the rooms of the laboratory, thus adding very materially to the interest and utility of the proceedings. The following list of the various communications and demonstrations will at least serve to show the large extent of ground covered by the subject-matter brought forward, and the activity with which physiological research is now being pursued.

MONDAY, AUGUST 29.—PRESIDENTS: PROF. CHAUVEAU (Paris), PROF. BURDON SANDERSON (Oxford).

A. *Communications.*

1. Hermann.—Phonophotography.
2. Rosenthal.—Results of observations with improved calorimetric methods.
3. Halliburton.—Nucleo-albumins.
4. Starling.—The fate of peptones in the blood and the lymph.
5. Max Cremer.—Experiments on the effects of feeding animals with certain sugars.
6. Langlois.—The functions of the suprarenal bodies.
7. Morat.—The innervation of the tensor tympani.
8. Hamburger.—The effect of different salts upon the properties of red blood corpuscles.
9. Céline Muro.—Physiological evolution.

B. *Demonstrations.*

1. Hürthle.—A new method of registering the sounds of the heart in man by means of a microphone.
2. Wertheimer.—(*a*) The excretion by the liver of bile introduced into the blood.
   (*b*) Vaso-dilatation effects of strychnia.
3. Laulanié.—The cardiograph (needle method).
4. Wedensky.—Demonstration by the telephone of the electrical changes which accompany the passage of nerve impulses, and the influence upon these of electrotonic alterations in nerve excitability.
5. Sherrington.—The cortical representation of the movements of the hallux and especially of the anus in the Macaque monkey.
6. Langlois.—The variations in the discharge of heat during "la maladie pyocyanique."

TUESDAY, AUGUST 30.—PRESIDENTS: PROF. KÜHNE (Heidelberg), PROF. HÉGER (Brussels).

A. *Communications.*

1. Bowditch.—Composite photography.
2. Olivier.—Protoplasmic continuity.
3. Schäfer.—The structure of the insect's wing muscles.
4. Schäfer.—The negative effects of severance of the frontal lobes of the cerebrum.
5. Vitzou.—(*a*) The visual centres of the dog and monkey.
   (*b*) The effects of total ablation of a cerebral hemisphere.

6. Wertheimer.—The elimination of pigments by the liver.
7. Loew.—The distinction between the "active" and the "passive" albuminous material of plants.
8. Sherrington.—The varieties of leucocytes.

B. *Demonstrations.*

1. Chauveau.—The changes in mammalian endocardiac pressure as recorded by the tambour and air transmission method. (This classical experiment formed the main part of the afternoon's work.)
2. Gréhant.—(*a*) Absorption of carbonic oxide by living organisms.
3. Gréhant and Martin.—On the physiological effects of opium.
4. Wedensky.—Demonstrations with the telephone upon nerve excitation and upon voluntary muscular contraction in man.
5. Zwaardemaker.—The mechanism of smell.

WEDNESDAY, AUGUST 31.—PRESIDENTS: PROF. WEDENSKY (St. Petersburg), PROF. GRIGORESCU (Bucharest).

A. *Communications.*

1. Cybulski.—The use of the condensor for the excitation of muscles and of nerves.
2. Hédon.—The effect of removal and of transplantation of the pancreas upon the production of diabetes mellitus.
3. Gotch.—The increased excitability of nerve and of muscle occasioned by low temperature.
4. Burch.—(*a*) The apparatus for photographing the movements of the capillary electrometer.
    (*b*) The method of analyzing the electrometer curves obtained by the photographic method.
5. Burdon Sanderson.—The electrical changes in muscle as shown by the capillary electrometer.
6. Fredericq.—Autotomy in crabs.
7. Jacobi.—The muscular sense.
8. Bayliss.—The functions of the depressor nerve.
9. Doyon.—Tetanus.
10. Wedensky.—The impossibility of causing fatigue in motor nerves.
11. Verworn.—The effect of galvanic currents on simple living organisms.
12. Moussu.—The functions of the thyroid body.
13. Slosse.—(*a*) The functions of the thyroid body;
    (*b*) Autopsy of a case of thyrodectomy in the dog.
14. Kaufman.—The intra-muscular circulation.
15. De Boeck.—The effects of partial ablation of the cerebrum immediately after birth.

B. *Demonstrations.*

1. Waller.—The discharge of heat from the muscles of man.
2. Gotch.—The increased excitability of the sciatic nerve of the cat produced by low temperature.
3. Grigorescu.—Action of certain poisons upon the central nervous system.
4. Cybulski.—Method of stimulating muscle and nerve by means of condensor discharges.
5. Mares.—Nerve excitation by means of varying induced currents due to variations in the rapidity of magneto-induction.
6. Wedensky.—The most favourable and the least favourable frequency for effective intermittent excitation of nerve by electrical currents.
7. Paton.—A crystalline globulin obtained from urine.

In addition the following members showed instruments and models:—

1. Lahousse.—Model of the nerve centres.
2. Rosenthal.—Calorimeter with recent improvements.
3. Laulanié.—(*a*) A universal inscribing manometer.
    (*b*) Apparatus for studying respiratory changes.
4. Morat.—Recording apparatus.
5. Cybulski.—The Photohæmotachometer.
6. Miescher and Jacquet.—A recording chronometer.

On Wednesday evening, at the conclusion of the proceedings, the members dined together in the large foyer of the theatre, the President of the Congress, Prof. Holmgren, being in the chair.

As the Congress is held every three years, the next meeting will take place in 1895, and it was decided that in response to the kind and cordial invitation of Prof. Kronecker, the meeting should be held in Berne (Switzerland).

ELECTRO-METALLURGY.[1]

THIS is not the first time a lecture has been delivered here on electro-metallurgy. I find that so long ago as January, 1841, there was a lecture on the subject by Mr. Brand.

At that time electro-metallurgy was very new and very small. It consisted solely of electro-plating and electrotype. Electro-plating had already begun to be practised as a regular industry, but it was still a question whether the new kind of plating was good, and there were not a few silversmiths who would not offer electro-plate for sale because of its supposed inferiority to plate of the old style. That question has long been definitely settled by the fact that every week more than a ton of silver is deposited in the form of electro-plate.

Electrotype in 1841 was not so far advanced—it had not then been taken hold of by the artisan and manufacturer—it was still in the hands of the amateur.

While the voltaic battery was the cheapest source of electric current, electro-metallurgy was necessarily restricted to artistic metal work, or to those applications where the fine quality of the electrotype cast outweighed the consideration of its cost, or where only a thin film of metal was required for the protection of a baser metal from the action of the air.

Within this limited field, the electro deposition of copper, of gold, of silver, of iron, and of nickel, has been carried on commercially with very great success and advantage for almost the whole period of the existence of the art. But beyond these bounds, set by the limitation of cost, it could not pass.

Now, all this is changed—since engineer and electrician have united their efforts to push to the utmost the practical effect of Faraday's great discovery, of the principle of generating electric currents by motive power. The outcome is the modern dynamo, with its result—cheap electricity. The same cause that has led to electric lighting, and to the electric transmission of power, has also led to a very great development of electro-metallurgic industry, and not only in the old directions but in new. It is no longer a matter of depositing ounces or pounds of metal, but of tons and thousands of tons. And it is no longer with metal deposition merely that electro-metallurgy now deals, but also with the extraction of metals from their ores, and the fusion and welding of metals. Electro-metallurgy has in fact grown so large and many-branching, that it is impossible to treat it in a complete manner in a single hour.

One of the latest developments is electric welding. This, in one of its forms, that invented by Elihu Thompson, has recently been so thoroughly explained and demonstrated by Sir Frederick Bramwell, that it is not necessary for me to do more than mention it as belonging to the subject.

There is also another species of electric welding—that of Dr. Benardos—in which the electric arc is used after the manner of a blow-pipe flame, to obtain the welding of such forms and thicknesses of iron, steel, and other metals, as would be difficult or impossible to weld in any other way; and not only is the electric blow-pipe used for welding, but also for the repair of defects in steel and iron castings, by the fusion of pieces of metal, of the same kind as the casting, into the faulty place, so as to make it completely sound. This new kind of electric welding, as improved by Mr. Howard, is now of sufficient importance to entitle it to the full occupation of an evening. I therefore propose to leave it for detailed description to some other lecturer, and content myself with calling your attention to the interesting collection of specimens on the table, and in the Library (lent by Messrs. Lloyd and Lloyd), showing the results of this process.

Even with this curtailment, the extent of the field is still too great, and I must reduce it further by omitting a considerable section of that portion which relates to the extraction of metals from their ores, and, in this connection, only speak of the extraction of aluminium.

But, in the first place, I am going to speak of the deposition of copper, and you will pardon me if I treat it as if you were unacquainted with the subject.

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[1] Friday evening discourse delivered by Mr. J. Wilson Swan, at the Royal Institution, on May 20.

One of the wonderful things about the electro-deposition of copper, and in fact any other metal deposited from a solution of its salt in water, is, that bright, hard, solid metal, such as we are accustomed to see produced by means of fusion, can, by the action of the electric current, be made to separate from a liquid which has no appearance of metal about it.

The beginning of every electro-deposition process is the making a solution of the metal to be deposited. I am going to dissolve a piece of copper, the most elementary of all chemical operations, but I want to make it quite clear where the metal to be deposited comes from—to show that it is actually in the solution, and actually comes out of it again; for that is an effect so surprising, that it requires both imagination and demonstration to make it evident. There is projected on the screen a glass cell containing nitric acid. Mr. Lennox will put into it a piece of copper. He has done so; it quickly disappears, and a blue solution of copper nitrate is formed. Now, if I pass an electric current through this solution, or through some solution of the same kind, which, to save time, has been prepared beforehand, and immerse in it, a little apart from each other—the positive and negative wires coming from some generator of electric current—this will happen: metallic copper will come out of the solution, and attach itself as a coating to the negative wire, and consequently that wire will grow in thickness. At the other wire—the positive—exactly the reverse action will take place. There, if the positive wire be copper, it will gradually dissolve, and become thinner. The quantity of metal deposited on the negative wire will almost exactly equal the quantity dissolved from the positive, and therefore the solution will contain the same quantity of metal at the end of the experiment as at first, but it will not be the same metal; it will be fresh metal dissolved from the positive wire, and the metal originally contained in the solution will have been deposited as metallic copper.

I will show on the screen this process in operation. Here are the two wires I spoke of. The electric circuit, which includes these two wires, is so arranged that on its completion the thick wire will be the positive, and the thin wire the negative. Now please complete the circuit. One wire (the positive) is carrying an electric current into the copper solution, and the other (the negative) is carrying the current away. The solution is conveying the current between the wires, and one of the incidents of the transport of current from wire to wire by the solution, is electro-chemical decomposition, or electrolysis; and the result of that is, the deposition, out of the solution, of copper, upon one wire, and the dissolving away, or entering into solution, of copper, from the other. Now it can be clearly seen that the wire that was thick is now thin, and the wire that was thin is now thick.

Imagine the growing wire to be an electrotype mould, and that the deposit of copper which formed on the wire has spread over the surface and formed a nearly uniform film, and that by continuing the process it has become thick, that deposit, stripped from the mould, would be an electrotype.

Or imagine the negative wire to be a thin sheet of pure copper, and the positive wire to be a thick sheet of impure copper, and suppose the action carried on so far that the thin sheet has become thick by the deposition of copper upon it from the solution, and the thick one thin by its copper entering into solution, that case would represent the condition of things in electrolytic copper refining.

Allow your imagination to take one more short flight, and suppose that this is not a solution of copper, but one of silver, and that the growing wire is a teapot to be silvered; and, further, suppose that the dissolving electrode is silver, and you will then understand the principle of electro-plating.

It requires very little explanation to make the ordinary arrangement of electrotyping intelligible. Here is a trough containing sulphate of copper solution. Here is a mould that, through the kindness of Messrs. Elkington, has been prepared for me; this is connected with the negative pole of a battery—and here is a plate of copper connected with the positive pole. When I immerse the mould in the solution—at about two inches from the copper plate—the electrical circuit is completed, and the same electrolytic action that the experiment illustrated will take place. Copper will be deposited on the mould, and will be dissolved in equal quantity from the copper plate, and the supply of copper in the solution will thus be kept up. As it will take a little time to obtain the result I wish to show, I will put this aside for ten minutes or so, and proceed to speak of different applications of this principle of copper deposition.

For the reproduction of fine works of art in metal, electrotype is unapproachable. The extreme minuteness with which every touch of graver or modelling-tool is copied by the deposited metal film, separates electrotype by a wide space from all other modes of casting. Even the Daguerreotype image is not too exquisitely fine for electrotype to copy it so perfectly that the picture is almost as vivid in the cast as in the original.

It is this quality that has given to electrotype a *rôle* which no other process can fill, and, so far, its practical utility is not greatly dependent on the cost of the current. This applies to all those most beautiful things here and in the Library, lent by Messrs. Elkington. These could all have been produced commercially, even if there had been nothing better for the generation of the current than Smee's battery—a very good battery, by the way, for small operations in copper deposition. It gives a very low electro-motive force and that is a defect, but in copper deposition, the half-volt or so is generally sufficient to produce, automatically, the required current destiny.

One of the uses of electrotype, not greatly affected by the cost of deposition, is that of the multiplication of printing surfaces. In these days of illustrated periodicals, electrotype has come more and more into use for making duplicate blocks from wood engravings, which would soon be worn out and useless if printed from direct. It is also employed to make casts from set-up type, to be used instead of ordinary stereotype casts, when long numbers of a book have to be printed; also as a means of copying engraved copper-plates. Here are examples of all these uses of the electrotype process. The electro-blocks are lent by Messrs. Richardson and Co., and the copper-plates by the Director-General of the Ordnance Survey Office, Southampton.

The plates illustrate the method employed at Southampton in the map-printing department. The original plates are not printed from except to take proofs. The published maps are all printed from electrotypes. Here is an original plate—here the matrix, or first electro, with, of course, all the lines raised which are sunk in the original. The second electro is, like the original, an intaglio. Here is a print from it, and here one from the original plate. Practically they are indistinguishable from each other, and bear eloquent testimony to the wonderful power of electrotype to transmit an exceedingly faithful copy of such a surface.

Nickel has, of late years, come into extensive use for what is termed nickel-plating, as applied to coating polished steel and brass with nickel. Nickel not only has the advantage over silver of cheapness, but also, in some circumstances, of greater resistance to the action of the air.

Another metal, usually deposited in the form of a coating, is iron. The electrolytic deposit of iron is peculiarly hard—so much so, that it is commonly but erroneously spoken of as *steel*-facing. The deposition of a film of iron upon engraved copper-plates, as a means of preventing the wear incidental to their use in being printed from, has become almost universal. Valuable etchings, mezzo-tints, and photogravure plates are thus made to bear a thousand or more impressions without injury. By dissolving off the iron veil with weak acid, when the first signs of wear appear on the surface of the plate, and re-coating it with iron, an engraved copper-plate is, for all practical purposes, everlasting.

In this case, of course, the film of iron is extremely thin—one or two hundred-thousandths of an inch. But it is possible to produce most of the metals commonly used as coatings in a more massive form. Here, for example, is an iron rod half-an-inch in diameter, entirely formed by electrolytic deposition. I am indebted to Mr. Roberts-Austen for being able to show this, and also for this other example of a solid deposit of iron, and for this beautiful specimen of electrolytic coating with iron. Here also are solid deposits of silver. This drinking cup is a solid silver electro-deposit.

These are all departments of electro-metallurgy which would have maintained a perfectly healthy industrial existence and growth without the dynamo; but now I come to speak of a branch of the subject—electrolytic copper refining—which, without that source of cheap electricity, could not have existed. This is the most extensive of all the applications of electro-chemistry, and is rendering valuable assistance to electrical engineering by the improvement it has led to in the conductivity of copper wire.

One of the results of this is seen in the raising of the commercial standard of electrical conductivity.

Ten years ago, contracts for copper wire for telegraphy stipulated for a minimum conductivity of 95 per cent. of Matthiessen's standard of pure copper. Now, chiefly owing to electrolytic refining, a conductivity of 100 per cent. is demanded by the buyer and conceded by the manufacturer.

To show the difference between the past and present state of things in relation to the commercial conductivity of copper, I am going to exhibit on the screen measurements of the resistance of six pieces of wire of equal length and equal cross section—they have been drawn through the same drawplate. Three of the pieces are new, and three are old. The three new pieces are made from electrolytic copper, and are representative of the present state of things. The three old pieces are taken from three well-known old submarine telegraph cables, and they show how very bad the copper was when it was first employed for telegraphic purposes, and how great has been the improvement. I will take No. 1 wire as the standard of comparison. It is a piece of the wire about to be supplied to the Post Office Telegraph Department for trunk telephone lines. It will show the very high standard of conductivity that has been reached in the copper of commerce. I am indebted for it, and for two out of three of the old cable wires, to Mr. Preece. No 2 wire is made from electrolytic copper, deposited in my own laboratory. No. 3 is also electrolytic copper, but such as is commercially produced in electrolytic copper refining; it has been supplied to me by Mr. Bolton, to whom I am also indebted for wire No. 6—a particularly interesting specimen: it is from the first Trans-Atlantic cable—the cable of '58. No. 4 wire is from the Ostend cable of 1860, and No. 5 wire is from the old Dutch cable. These wires are so arranged that I can send a small and constant current partly through any one of them, and partly through a galvonometer. When this is done the result will be a deflection of the spot of light on the scale from the zero point to an extent corresponding to the resistance of the particular wire in the circuit. The worse the wire is, the greater will be the deflection. We will begin with the Post Office sample first. I connect the galvanometer terminals to wire No. 1; you see there is a deflection of ten degrees. I will now shift the contacts to wire No. 2—exactly the same length of wire is included—but now you see there is a deflection of slightly less than ten degrees, showing that this wire has a little lower resistance than No. 1. The difference is very small—it may be 2 per cent.—and 2 per cent. less of it would be required to conduct as well as the No. 1 wire. The next is No. 3. This is Mr. Bolton's wire, and shows a resistance almost equal to the last.

No. 1, 2, and 3 are, therefore, nearly alike, and have a degree of conductivity almost as high as it can possibly be.

Now we come to the three old wires.

We will take No. 4 (the Ostend cable). There, you see, is a great difference. Instead of the spot of light being on the tenth degree, it is upon the eleventh.

We will now try No. 5 (the Dutch cable). That drives the index to 17.

Now I change to No. 6 (the old Atlantic cable), and we have a deflection of no less than 25 degrees. I suppose we may assume that this wire fairly represents the commercial conductivity of copper in 1858, for it is highly probable that for a work so important as the first Atlantic cable every care would be taken in the selection of the copper.

The result of this experiment shows that the copper of that cable was extremely bad as a conductor—that, in fact, it is 150 per cent. worse than the best commercial copper of to-day. In other words, it shows that, in point of electrical conductivity, one ton of the copper of to-day will go as far as two-and-a-half tons of such copper as was used for the cable of '58.

This change is largely due to electrolytic copper refining.

The process of electrolytic copper refining is the same in principle as that which produced the thickening of one of the wires and the thinning of the other in my first experiment. To prepare the crude copper for the refining process it is cast into slabs; these form the anodes, and correspond to the wire which in my first experiment became thin. The cathodes, corresponding to the wire which became thick, are formed of thin plates of pure copper. Here are plates such as are used in electrolytic copper refining works. They are portions of actual cathodes and anodes, and represent the state of things at the commencement, and at the end, of the depositing operation—an operation that takes several weeks to complete, and effect the great change these plates show. In copper refining works an immense number of these plates, each having 6 to 10 square feet of superficial area, are operated upon together in a great number of large wooden vats containing sulphate of copper solution and a small proportion of sulphuric acid. Electric current from a dynamo, driven by a steam-engine or water-power, is conveyed by massive copper conductors to the vats, arranged in long lines of 50 or 100 or more in series. Thick copper bars connect adjoining vats, and provide a positive and negative support for the plates, which hang in the solution opposite each other, two or three inches apart. During the process the impure slabs dissolve, and at the same time pure copper is deposited from the solution upon the thin plates. The deposition and dissolving go on slowly, in some cases very slowly, for a slow action takes less power, and gives purer copper than a more rapid one. The usual rate is one to ten ampères per square foot of cathode surface. You will better realise what these rates of deposit mean, when I say that one ampère per square foot rate of deposition gives for each foot of cathode surface, nearly one ounce of copper in twenty-four hours, and a thickness of one-eighth hundred of an inch; and therefore the production of one ton of copper at that rate in twenty-four hours would require a cathode surface in the vats, in round numbers, of 36,000 square feet. At the higher rate of ten ampères per square foot, which is used where coal is cheap, one-tenth of this area would be required.

The importance of the electrolytic copper refining industry, and the extent of the plant connected with it, may be inferred from the fact that, reckoning the united production of all the electrolytic copper works in the world, nearly one ton of copper is deposited every quarter of an hour.

Very little power is required for copper deposition if the extent of the dissolving and depositing surfaces is large, relatively to the quantity of copper deposited in a given time.

Some of the impurities ordinarily found in crude copper are valuable. Silver and gold are common impurities, and these and some other impurities do not enter into solution, but fall down as black mud, are recovered, and go to diminish the cost of the process or increase the profit; and even those impurities which enter into solution are, under ordinary conditions, almost completely separated.

Electrolytic copper refining is both an economical and an effective process. The deposited copper is exceptionally pure. At one time it was supposed that it must necessarily be quite pure, but this is not the case; other metals can be deposited with the copper, but it is not difficult to realise in practice a close approximation to absolute purity in the deposited copper. Here is an example of the deposition of a mixed metal—brass, that is, copper and zinc deposited together, and there are in the Library a number of interesting specimens of mixed metal deposition. These deposits of brass and other alloys show that more than one metal can be deposited at the same time. The great enemy to conductivity in copper is arsenic, and the deposition of arsenic as well as copper is one of the things to be guarded against in electrolytic copper refining. Not only are the chemical characteristics of electrolytically refined copper generally good, but its mechanical properties are largely controllable. Usually electrolytic copper is melted down and cast into billets of the form required for rolling and wire-drawing. This treatment not only involves cost, but the copper is apt to imbibe impurity during fusion; though, if the process is carefully conducted, the deterioration is slight.

But it is evident that the re-melting of the deposited copper is a thing to be avoided if possible, and the question naturally arises, why, now that deposition costs so little, may not the beautiful principle which comes into play in electrotype, and which enables the most complicated forms to be faithfully copied be taken advantage of to give to plainer and heavier objects their ultimate form?

There are several reasons why this idea is not more frequently acted upon. One is that the process of electrolytic deposition is slow; another, that knowledge of the conditions necessary for obtaining a deposit having the required strength and other qualities, is not very widespread. Moreover, in the electrolytic deposition of copper, and indeed of all metals, there is a strong tendency to roughness on the outside of the deposit, and to excrescent growths, the removal of which involve waste of labour and material. These tendencies can to a very great extent be counteracted by careful manipulation and the use of suitable solutions, and they can also be counteracted by mechanical means. This has been done by Mr. Elmore. He remedies the faults I have mentioned by causing a burnisher of agate (arranged after the manner of a tool in a screw-cutting lathe) to press upon and traverse a revolving cylindrical surface on which the deposit is taking place, and while it is immersed in the copper solution. The result is that it is kept smooth and bright to the end of the process.

But the use of a burnisher is not the only means available for the production of a smooth deposit. It was observed in the early days of electro-plating how great a change was effected in the character of the metal deposited by the presence of a very small quantity of certain impurities. It was found, for example, that an exceedingly minute dose of bisulphide of carbon, if put into a bath from which the silver was being deposited, caused the deposit to change from dull to bright.

I have lately had experience of a similar kind with nickel and with copper. I was working with a hot solution of nickel, and up to a certain point the deposit had the usual dead-grey appearance. Suddenly, and without doing anything more than putting in a new cathode, I found the character of the deposit completely changed. Instead of the grey, tough, adherent deposit, there was produced a brittle, specular deposit, which scaled off in brilliantly shining flakes of metal. I sought for the cause of this extraordinary change, and traced it to the accidental introduction into the solution of a minute quantity of glue.

By adding gelatine to a fresh nickel solution I obtained the same peculiar bright and brittle deposit that had resulted from the accident. I then made a similar addition to a solution of copper, and when I hit the right quantity—an exceedingly minute one—bright copper, instead of dull or crystalline, was deposited. Here are some specimens. These were deposited on a bright surface, and they are bright on both sides.

Not only is the copper made bright, under the conditions I have described, but, if the proportion of the gelatine be carried to the utmost that is consistent with the production of a bright deposit, it becomes exceedingly hard and brittle. Beyond this point the deposit is partly bright and partly dead, the arrangement of the patches of dead and bright being in some cases very peculiar, and suggestive of a strong conflict of opposing forces.

Before I leave the subject of copper deposition, I may mention that I have found the range of current density within which it is possible to obtain a deposit of reguline metal, far wider than is commonly supposed.

The rate of deposition in copper-refining is usually very slow, and it is one of the drawbacks of the process, since slow deposition necessitates large plant. But rapid deposition necessitates a larger consumption of power, and larger cost on that account, and therefore, there is a point beyond which it is not good economy to go, in the direction of more rapid deposition. Still there are cases, where, if we had the power to deposit more rapidly, it might be found useful to exercise it. The subject of more rapid deposition is also interesting from a scientific point of view, I therefore mention an unusual result I have arrived at in this direction.

Taking as one extreme, the slow rate of deposit, of one ampère per square foot of cathode—a rate not infrequent in copper-refining, I have found that the limit in the other direction is not reached by a rate of deposit one thousand times faster. I have produced, and I hope to be able to produce before you, a perfectly good deposit of copper, with a current density of 1000 ampères per square foot of cathode.

This cell contains a solution of copper nitrate with a small proportion of ammonium chloride. The plate on which I am going to produce a deposit of copper has an exposed surface of 21 square inches. Opposite, at a distance of one inch, is a plate of copper. When I close the circuit, a current of 140 ampères is passing through the solution. I continue this for just one minute. Now I wash it and remove the outer edge so as to detach the deposit, and as you see, I have a sheet of good copper—an electrotype.

To have produced a deposit of this thickness at the ordinary rate used in electrotyping operations would have occupied more than an hour.

In this experiment an extreme degree of rapidity of deposition has been shown. I do not intend to suggest such a rate of practical value. But it is at least interesting, as showing that the characteristic properties of copper are not less perfectly developed when the atoms of metal have been piled up one on the other at this extremely rapid rate than when there is slower aggregation.

I think it probable that a rate of deposit intermediate between this rate and the usual one of about 10 ampères per square foot may frequently be useful, for no doubt the slowness of the rate of deposit has often prevented electrotype from being made use of where, if the rate could have been increased ten times, it might have been used with advantage.

Here are some thick plates, deposited at the rate of 100 ampères per square foot. They are as solid and as free from flaw as plates deposited ten times more slowly.

I said that electrolytic copper-refining owed its existence to the discovery and improvement of the dynamo, and that other electro-metallurgic industries had originated from the same cause. One of these industries is the electrolytic production of aluminium.

When Deville produced aluminium by the action of sodium on aluminium chloride, exaggerated expectations were entertained of the great part it was about to play in metallurgy. It was very soon found that aluminium had not all the virtues that its too sanguine friends had claimed for it, but that it had a great many most valuable properties, and, given a certain degree of cheapness, a number of useful applications could be found for it. Some of these are suggested and shown by the various articles made of aluminium, kindly lent by the Metal Reduction Syndicate, and metallurgical research is rapidly extending our knowledge of its importance in connection with the improvement of steel castings, and the production of bronzes and other alloys of extraordinary strength. The cost of aluminium produced by Deville's process was too great to permit of its use on any large scale for these purposes.

After Davy demonstrated, by the electrolytic extraction of potassium and sodium, the power of the electric current to break down the strong combination existing between the alkaline metals and oxygen, it seemed natural to expect that aluminium would also be reduced by the same means. But Davy did not succeed in producing any appreciable quantity of aluminium by the electrolytic method. Deville and Bunsen were more successful, but they did not possess the modern dynamo: that has made all the difference between the small experimental results they achieved and the industrial production of to-day, a production now so large that I suppose every day it amounts to at least one ton, and has resulted in a very great reduction of the price of the metal.

There are two electrolytic processes at work. One is the Hall process—employed at Pittsburg, and at Patricroft, Manchester—and now in experimental operation here. The other, the Herault process, worked at Neuhausen, is not greatly different from the Hall process—the shape of the furnace or crucible is different, and the composition of the bath yielding the aluminium may be different, but in all essentials these two processes are one and the same. They depend on the electrolysis of a fused bath, composed of cryolite, aluminium fluoride, fluorspar, and alumina. In the Hall process this mixture is contained in a carbon-lined iron crucible—the cathode in an electric circuit; and between which and the anode—a stick of carbon immersed in the fused bath—a difference of potential of 10 volts is maintained. In carrying out the process on a manufacturing scale, there are many of these sticks of carbon to each bath. Here, in our experimental furnace, there is only one.

The heat developed by the passing of so large a current as we are using (180 amperes) through an electrolyte of but a few inches area in cross section, is sufficient to melt and keep red-hot the fluorides in which the alumina is dissolved.

The electrolytic action results in the separation of aluminium from oxygen. The metal settles to the bottom of the pot, and is tapped or ladled out from time to time as it accumulates. The oxygen goes to the carbon cylinder, and burns it away at about the same rate as that at which aluminium is produced. It is only necessary to keep up the supply of alumina to enable the operation to be continued for a long time. I mean, of course, in addition to the keeping up of the current and the supply of carbon at the anode.

By far the greater part of the cost of aluminium obtained by electrolysis is the cost of motive power: 20 horse-power hours are expended to produce 1 pound of aluminium. Therefore it is essential for the cheap production of aluminium to have cheap motive power.

There is one feature about the Neuhausen production of aluminium which is very striking, and that is the generation of the electric current by means of water power derived from a portion of the falls of the Rhine at Schaffhausen.

The motive for making use of water power is economy. But, apart from that, it is interesting to see water replacing coal, not only in the production of power, but also in the production of the heat required in a smelting furnace.

Here is the Hall apparatus on a small scale. It is simply a carbon-lined iron crucible, and a thick stick of carbon. As already mentioned, the crucible is the cathode, the stick of carbon the anode.

As the process takes time to get into full operation, it was commenced some hours ago, and at the rate at which it has been working we should by now have produced several ounces of aluminium. In beginning the process the charge has first to be melted. This is done by bringing the carbon stick into contact with the bottom of the crucible, so as to allow the current to pass from carbon to carbon to develop heat between the electrodes.

The alumina compound, which, when melted, forms the bath, is added, in powder, little by little, and, when sufficient is melted, the carbon stick is raised out of contact with the bottom, and the electrolytic action then commences.

I will now ask Mr. Sample to empty the crucible and let us see the result of the operation, and while he is doing so I take the opportunity of expressing my very sincere thanks for his having so kindly and so successfully carried out this most interesting demonstration of the latest and one of the most important of all the applications of electricity to metallurgical operations.

Here is the result of our experiment. It is not very large certainly, but it is quite enough for our purpose, which is to illustrate the principle of a newly developed electro-metallurgical industry directly derived from discoveries made at the Royal Institution.

MOUNT MILANJI IN NYASSALAND.

HIDDEN in the recesses of one of the recently issued Parliamentary Papers (Africa, No. 5, 1892) will be found a very interesting report on the mountain and district of Milanji, in British Central Africa, by Mr. Alexander Whyte, F.Z.S., one of Mr. Commissioner Johnston's principal assistants in the task of ruling and developing the new British Protectorate of Nyassaland. Mr. Whyte was sent to Milanji by Mr. Johnston in October last, and dates his report from the "Residency, Zomba, British Central Africa," in the month following. Milanji is a large mountain mass in the extreme south-east corner of Nyassaland, drained on the west by the head waters of the Ruo, one of the affluents of the Shiré, and on the east by the Lukuga and other smaller streams, which run into the Indian Ocean north of the Zambesi. It is described by Mr. Whyte as an isolated range of, for the most part, precipitous mountains, the main mass forming a huge natural fortress of weather-worn precipices or very steep rocky ascents, sparsely clothed with vegetation. Many of its gullies and ravines are well wooded, and in some of them fine samples of grand African virgin forest are met with. Mr. Whyte's ascent, on the 20th of October, was made up the south-east face of Milanji, over steep grassy hills and across rocky streams, full of large water-worn granite boulders. Further on precipices were encountered, and it was necessary to clamber up, holding on by tufts of grass, roots, and scrub, after which a wooded gorge was entered, and welcome shade was obtained from the forest trees.

Here an interesting change in the vegetation was at once perceptible, the plants of the lower slope being mostly replaced by other species. These in many cases approached the flowers of temperate climes, such as brambles and well-known forms of *Papilionaceæ* and *Compositæ*. Ferns, too, became more numerous, and now and again were encountered perfect fairy dells of mosses, Selaginellas, and balsams, with miniature water-falls showering their life-giving spray on the little verdant glades, while overhead hoary lichens and bright festoons of elegant long-tasselled Lycopods hung from the moss-covered trees. After they had passed through some dense thickets of bamboo, and climbed up an ugly barrier of precipitous cliffs, another hour's ascent, the latter part of which was through a steep grassy glen, brought Mr. Whyte and his companions to the highest ridge of Milanji.

Hence was a splendid view over rolling hills of grassy sward divided by belts of dark-green forest, and the climate was found to be delightfully cool and bracing, with a clear dry atmosphere of about 60° Fahr. Altogether two weeks were spent at three different sites on this high plateau, and good collections of its natural history were made, although rain and mist occasionally interfered with the operations of the naturalists.

The flora of the mountain proved to be of great interest, being quite distinct from that of the surrounding plains, and even from that of the lower slopes. Tree-ferns were found to attain a great size in the damp, shady forest, and one was measured 30 feet in height and 2 feet in diameter at its base. The display of wild flowers is described as "gorgeous." Creamy-white and yellow helichrysums mingled with purple and blue orchids and irises, and graceful snow-white anemones were all blooming in wild profusion, and rearing their heads from a bed of bright green grassy sward. But the most striking botanical feature of the Plateau of Milanji was the cypresses formerly apparently quite abundant, but now confined to a few of the upper ravines and valleys, where the annual bush-fires, which take place in the dry months of August and September, cannot reach them. In some places hundreds of these giant trees thus destroyed lay prostrate, piled one above another, in every stage of destruction. One of these dead conifers was found to measure 140 feet in length and 5½ feet in diameter at 5 feet from its base. The foliage of this cypress is juniper-like. The timber, of a dull reddish-white colour, is of excellent quality and easily worked. Ripe cones of this fine tree were procured, and, as stated in a subsequent letter, have already germinated in the experimental garden at Zomba.[1]

The fauna of the mountain was found to be of nearly equal interest to the flora, but in the short space of time available it was not possible to make so nearly a complete collection. Raptorial birds were very scarce, but Passeres were plentiful. The grassy lands of the summits were tenanted by a small dark brown quail, a pipit, two grass-warblers, and the ubiquitous great-billed raven (*Corvultur albicollis*), which, however, was not so numerous as on the plains below. In the adjoining forest bird-life was abundant. Bul-buls, fly-catchers, warblers, finches, and honey-birds joined in chorus in celebrating the springtime and nesting season, which was then in full progress. Altogether about 200 specimens of birds were obtained. Of mammals few were met with. The beasts of prey consisted of the leopard, the spotted hyæna, the serval, and an ichneumon. Examples of three species of *Muridæ* were also obtained, and a little antelope, probably of the genus *Neotragus*, was observed, but not procured. A few snakes were likewise met with.

As regards the question of establishing a sanatorium on the Milanji Plateau, to which special attention had been directed, Mr. Whyte has no hesitation in saying that the climate of this district contrasts very favourably with that of some of the hill-stations in India and Ceylon. The year is pretty equally divided between wet and dry months, the former lasting from November till May, while the other six months are stated to be fine, clear, and bracing, the thermometer at night in the months of May, June, and July occasionally falling below the freezing point. In the month of October the air was found to be delightfully pure and balmy. We believe that steps have already been taken to build a small station on Milanji, but to render this of much use it will be necessary to form a road to it from the falls of the Ruo up the Lutshenya valley. This could be made with fairly good gradients, and would be of great advantage as an outlet for the cypress-timber, which now lies useless and decaying in the forest.

We are pleased to be able to add that Mr. Whyte's collections above spoken of, along with others from Mount Zomba, have already reached London, and are in the hands of Mr. Sclater, to whom Mr. Johnston has entrusted the task of getting them worked out and described. Mr. Oldfield Thomas has already commenced to determine the mammals, Captain Shelley will name the birds, and Mr. Boulenger, it is believed, will undertake the examination of the reptiles and batrachians. The plants will be examined in the Botanical Department of the British Museum, in which institution Mr. H. H. Johnston has directed the first set of specimens in every department to be deposited. The zoological results will be published in the "Proceedings" of the Zoological Society of London.

OBSERVATIONS OF THE PLANET MARS.[2]

I OUGHT to have written to you before on the subject of the planet Mars, which I have been studying for over four months with our great equatorial. My great desire to verify the extraordinary phenomena to which I alluded in my last letter may account for this.

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[1] Some cones of this supposed "Cypress" have also reached the Botanical Department of the British Museum, and have proved to belong to a Conifer of the genus *Widdringtonia*, probably of a new species. But this point cannot be definitely settled until more perfect specimens of the tree have been received.

[2] Letter from M. Perrotin to M. Faye, *Comptes rendus*, September 5.

Besides, I have gained nothing by waiting, and at the present time, after successive delays which I much regret, I am hardly further than I was a month ago. Owing, perhaps, to the images being less satisfactory, or to the phenomena in question not having recurred, nothing has been added to my first observations.

The phenomena alluded to are brilliant projections, comparable in colour and brightness to the southern pole cap, observed on three different occasions—viz., June 10 and July 2 and 3, on the western limb of the planet.

The last time, July 3, I was able to observe the several phases of this singular appearance. On that day the luminous point began to emerge on the edge of the disc at 14h. 11m. (local astronomical time), very faint at first; then I saw it gradually increase, pass through a maximum, and then diminish, to disappear finally about 15h. 6m. The facts would not have been different had it been a case of an elevation of the surface of Mars traversing the illuminated edge of the disc by the simple effect of the rotation of the planet. The phase which affected the western limb of the planet at that time, could only modify it in amount and in duration. The previous night, July 2, I had seen the crescent in a phase approaching the maximum, at 14h. 10m., and I was able to follow the bright point up to its complete disappearance at 14h. 40m.

On July 2 and 3 the things happened in the same part of the disc, about the 50th parallel of latitude, and with a retardation of half an hour against the previous day, as usual for a thing taking place in the same region of the planet.

The first observation of this kind goes back as far as June 10, when it lasted from 15h. 12m. to about 16h. 17m. This time the bright point occurred in the vicinity of the 30th southern parallel, probably in the southern portion of the isthmus Hesperia of Schiaparelli's chart.

I may add that during these observations the portion of the disc adjoining the small protuberance has always appeared to me slightly deformed and as if raised.

Such are the facts. I shall not attempt to interpret them. They presented themselves with such clearness that it is hardly possible to consider them as the result of any illusion.

On the other hand, since it is a question of projection beyond the disc of at least one or two tenths of a second of arc, that is to say, of phenomena at a height of more than 30 or 60 km., one feels overwhelmed by such numbers, to which we are not accustomed on our globe, and it is undoubtedly luminous phenomena only which could explain heights like that.

The southern snow cap has been the object of several measurements, which will be published with the drawings of this opposition. This cap has notably diminished in the last two months; it is, in fact, shifting; it is traversed by at least two black lines, a kind of crevices analogous to those which I announced in 1888 in the case of the northern cap. The first of these lines was seen at the end of June, the second on August 8.

The outline is now more irregular than in the past; in particular there is seen, between the meridians of 300° and 0° (Schiaparelli's map), a deep black hollow which grows steadily.

Although the actual conditions are not very favourable for the canals (at least for a portion of them), several are well visible; some are apparent enough to convince the most prejudiced observers.

Two of our drawings of the Great Syrtis, made at widely different dates, indicate some slight changes in the most northerly portion of this sea. They are no doubt due to mists and clouds, which have sometimes appeared to me to invade the northern regions on the east of this Great Syrtis, hiding the canals which traverse them, and only allowing us to see their most southern portion.

Our drawings of the Lake of the Sun, when compared with those of M. Schiaparelli, also indicate some changes of detail in the aspect of the lake itself and of the seas and canals surrounding it.

The most interesting observation of this month is the one I have made, on August 6, of a very bright point placed precisely a little to the north of this Lake of the Sun. This point, which struck me by its extraordinary radiance, could not be seen the next day; if it still existed—the images were not so good as the previous night—it was certainly much less luminous.

This phenomenon, and the analogous phenomena sometimes noticed on the surface of the planet, are perhaps not without some relation with the appearances of the limb which I have announced. Future observations will no doubt inform us on this subject.

I should perhaps have still deferred sending this letter if I had not, within the last few days, received from Mr. Newcomb the extract of a journal, in which it is reported that the Lick astronomers have also observed the luminous projections on the edge of the disc.

I may add that in the beginning of July I had imparted my observations to M. André, director of the Lyons Observatory, who happened to be on a visit to Mont Gros, and whom I had invited to come on the 5th and verify the strange appearances which I had told him of. Unfortunately, the sky remained obscured all night, and my project could not be carried out.

SCIENTIFIC SERIALS.

THE *American Meteorological Journal* for August contains :—Synoptical sketch of the progress of Meteorology in the United States, by W. A. Glassford, and reprinted from the annual report of the chief signal officer for 1891. From this summary it appears that Isaac Greenwood, a professor of mathematics in Harvard College, prepared a form for observations at sea in 1728, thus anticipating the efforts of Lieut. Maury by more than a century. Observations of temperature and rainfall were begun in Charleston in 1738, and were soon followed by several other series. In 1817, J. Meigs, Commissioner of the General Land Office, proposed to Congress the establishment of meteorological stations at each of the land offices, and as this proposal was not adopted, he started a voluntary system among his subordinates, and supplied registers for the purpose. This system lasted until his death in 1822. The next service was established by the Surgeon-General of the Army, in 1819, and was maintained, with modifications, until 1854, when the records were handed over to the Smithsonian Institution, and in due time were transferred to the Signal Service. The Patent Office, of which agriculture formed a division, and the Coast Survey also manifested great interest in the science. The article contains a good review of the labours of the principal American meteorologists.—Note on winter thunderstorms; by Prof. W. M. Davis. He asks whether the convectional origin of thunderstorms in summer implies a like origin for thunderstorms in winter, even though they occur then at night, and he explains the reasons which seem to favour this supposition.—Objections to Faye's theory of cyclones; by W. C. Moore. The writer attempts to show why the generally accepted theories seem to him preferable to those brought forward by M. Faye. The discussion is to be continued in a future number.—Artificial rain; by E. Powers. The writer is the author of a work entitled "War and the Weather," and he supports the view that rain can be artificially produced, and endeavours to refute the objections urged by Prof. W. M. Davis and others.

Wiedemann's Annalen der Physik und Chemie, No. 8.—On the refraction of rays of great wave-length in rock-salt, sylvine, and fluorspar, by H. Rubens and B. W. Snow. A series of bolometric researches concerning the infra-red rays, to determine the refractive indices of the three substances for light of various wave-lengths up to $\lambda = 80{,}000$. Fluorspar, though showing a lesser dispersion than the other two in the visible portion, excelled them enormously in the infra-red, hence it is specially suited for the production of prismatic heat spectra.—Reflection and transmission of light in certain æolotropic structures, by H. E. J. G. du Bois. An æolotropic structure is a portion of matter, generally plane, in which it is possible to fix upon an optically favoured direction. This can be due to its coarse macroscopic or its molecular and microscopic structure. In both cases vertically incident or reflected light will be acted upon differently according as its plane of polarization is parallel or normal to the favoured direction. This action is in general unequal as regards both the amplitude and the phase of the two components. The objects experimented upon were, in the first class, bright silver wire gratings, platinum film gratings, scratched metal reflectors, and scratched glass gratings; in the second class, crystals of cobaltine and pyrites, and a loaded steel mirror. In the case of the silver wire gratings it was found that light polarized in a plane normal to the direction of the wires was let through in greater intensity than that polarised parallel to them. The contrary was observed in scratched glass gratings, while a scratched metal mirror reflected 4 per cent. more perpendicular than parallel light.—The limiting index of refraction for infinitely long waves; transformation of the equations of dispersion, by E. Ketteler. The determination of the limiting coefficient of refraction is shown to be impossible, both in practice and by the current theory. Another form of the equation of motion of light is worked out, which promises a solution of the problem.—On the electricity of waterfalls, by Ph. Lenard. Numerous observations and experiments concerning the electricity developed by water falling in drops, jets, or waterfalls have led to the following general conclusions: Drops of water falling on to water or a wetted body generate electricity. Water is electrified positively, air escapes negatively electrified from the foot of the fall. Jets breaking up into spray make the electrification more apparent. Slight impurities in the water diminish the effect considerably. Other liquids and gases also produce electrification, but differing in intensity and sign. The essential conditions of electrification are the concussions among the waters themselves and against the wet rock. The friction against the rock and the fall of the earth-potential are of secondary importance, while no effect is due to the water's fall through air and its dispersion in it. The author explains these phenomena by the sudden diminution of the water surface, and the convection of negatively charged air away from the foot of the fall. A jet of water falling from an insulated tank into an insulated pail electrified the latter positively, while the negative electrification of the surrounding air grew to several hundred volts. A steady increase of potential was also produced by drops of water falling at the rate of two per second. Sparks were sometimes obtained from waterfalls, and in all cases the air was found to be negatively charged, though this charge was diminished if air bubbles were driven under water.—Note on a phosphoroscope with spark illumination, by Ph. Lenard. This ingenious apparatus consists of a Ruhmkorff coil with condenser and mercury interrupter, fitted with terminals of strip zinc or zinc wire, in order to produce as much ultra-violet and phosphorescent light as possible. The arm of the mercury interrupter is prolonged, and carries at its end a rectangular shade of black paper, large enough, in its mean position of rest, to hide the spark and the terminals. Hence when the coil is working the sparks are not seen. But if a phosphorescent substance be placed behind the terminals, it continues to glow when the screen is at its highest or lowest position, thus producing the impression as if the screen, which appears perfectly stationary, were only transparent for phosphorescent light. For lecture purposes the apparatus is placed behind a screen with an opening as large as the black paper shade. The results are in general the same as those of Becquerel's phosphoroscope. A brilliant green light is obtained from pentadecylparatolylketone. The interval between illumination and observation is $\frac{1}{600}$ second.—On the production and observation of very rapid electric oscillations (continued), by A. Toepler.—On the use and mode of action of the telephone for electric null methods, by A. Winkelmann.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, Sept. 5.—M. de Lacaze-Duthiers in the chair.—Note on the treatment of cancer and cholera by the testicular liquid, by M. Brown-Séquard. Some recent results seem to indicate that the testicular liquid, already proved to be efficacious in cases of pulmonary tuberculosis, leprosy, and other diseases, also exerts a beneficial influence on cancer patients. This is not due to any action upon the microbes producing the disease, but to an augmentation of the powers of the nervous system, which is enabled to resume its normal functions by subcutaneous injections of the extract. M. Ouspensky, a military physician sent by the Russian Government to study and cope with the cholera in the Caucasus, is reported to have "cured every patient" by this method. Whether or not this be true, there is no doubt that the injections strengthen the nervous system, which is much exhausted even in convalescents.—Observations of the comet Denning (1892, II.) made at the great equatorial of the Bordeaux Observatory, by MM. G. Rayet, L. Picart, and F. Courty, reported by M. G. Rayet.—Observations of the planet Mars, by M. Perrotin [see p. 482].—Reappearance of the leafy celandine of Pumeterre, by M. D. Clos.—Observations of the new comet Brooks (C. 1892), and of the new planet Wolf, made at the Observatory of Paris (west equatorial), by M. G. Bigourdan.—Observation of the comet Brooks (August 28, 1892), made with the Brunner equatorial (0·16) of the Lyons Observatory, by M. G. Le Cadet.—On the calculation of inequalities of a high order, by M. O. Callandreau.—On a new form of induction apparatus, by M. J. Morin. The induction coils usually employed in electrotherapy are constructed with two cylindrical and concentric bobbins, sliding one over the other, and giving the maximum effect when the coils coincide along their whole length. There is a difficulty in reaching the zero by a regular diminution of the current. This is obviated in the apparatus as constructed by M. Morin. The conducting wires are wound on two flat concentric rings provided with channels of appropriate form. When an intermittent current is sent through the outer ring induced currents will be obtained from the inner ring. The effect will be greatest when the two rings are in the same plane. If one of these rings be turned round a diameter common to both the induced current will gradually diminish, and will vanish when the one ring is at right angles to the other. This arrangement could be employed for obtaining alternate currents by sending a continuous current through one of the rings and rotating the other. A sinusoidal current would be thus generated, the effects of which have been lately much appreciated in electrotherapy. For electric lighting the number of alternations might be increased by transforming the currents into induced currents of a higher order, by Prof. Henry's method, utilized recently by M. Tesla.—Removal of the thyroid in the white rat, by M. H. Cristiani (Geneva). The apparent immunity of the rat from the fatal effects of the removal of the thyroid is shown to be due to the rapid regeneration of this organ. If the extirpation is total, death, otherwise inevitable, can be averted by grafting the organ in the peritoneum.

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THURSDAY, SEPTEMBER 22, 1892.

A 5-SENSATION THEORY OF VISION.

Color Vision. By E. Hunt. (Glasgow: John Smith and Son, 1892.)

THE author entitles his work, "An essay discussing existing theories, explaining views hitherto incompletely published, and comprising illustrated descriptions of important new experiments." We shall now proceed to see how the promise conveyed by the title is fulfilled. In the early pages of the book he makes the statement that there are five colours which are distinct sensations, viz., red, yellow, green, blue, and purple. The last, however, he is rather less certain about as conveying his meaning, but finally adopts the name after explaining what he designates by purple. These are the five colours of a 5-colour theory which he propounds, all other colours being mixtures. He has felt, however, that it is no use to bring forward a theory unless he demolishes those other theories which block the way. His examination of these last is chiefly confined to that of Young, which accounts for colour-vision on the assumption that there are only three colour sensations—a number which is a minimum when the fact is remembered that all colours can be produced by a simple colour, or by a mixture of two or three of the colours which are considered to be primary colours. His criticism of the theory is mostly confined to a paper published by Clerk Maxwell thirty years ago, and he scarcely refers to any evidence in its support which has been brought to light in more recent years. Mr. Hunt has entangled himself in mixing up colour and colour sensations together, and has forgotten that in Clerk Maxwell's papers three colours were chosen empirically as approaching the colours which are perceived when the three fundamental sensations are stimulated. Later work has shown that the colours thus shown are not representative of the fundamental sensations. No one, for instance, would say that any green in the spectrum was the colour evoked by the stimulation of the green fundamental sensation, for it is well known that, according to the theory, at every part of this region of the spectrum all three sensations are stimulated, and the nearest approach that a retina possessing normal sensations could make to perceiving this one sensation, would be when the colour evoked was mixed with a percentage of white, rendering the colour impure. We may here parenthetically remark that it is too late for Mr. Hunt to quarrel with the designations of the colour constants, for they are accepted terms. "Impure," for instance, may be an objectionable term to apply to a colour when mixed with white, but as what is meant by it is understood, it can only be used in that sense. The position of the colour which stimulates only the red fundamental sensation is fairly well known, being near to the red lithium line. The position of the colour which stimulates the violet fundamental sensation is still not absolutely settled, but it cannot be very far from the G line of the solar spectrum. Moreover, recent researches show that at the extremities of the spectrum only a red or a violet sensation is stimulated, any change in colour observed being due to a slight admixture of white light, which is derived from the imperfect transparency of the prisms or reflecting surface of the grating. The colour, for instance, near G, when mixed with a small percentage of white light, in excess of that already mixed with it, takes a violet hue, a colour which is associated with the most refrangible part of the spectrum. As the luminosity of this part is very much less than that near G, the extra percentage of white light required to form this hue is always present. The colour of any ray of the spectrum can be almost entirely freed from the white light derived from the prism by placing another prism in the path of such rays, after passing through a second slit. In an eye-piece or on a screen, the ray will be seen as a well-marked line lying in a faint continuous spectrum. Again, the references to the sensations stimulated in the various types of colour-blind people are not described in any detail, though the evidence which is derived from an examination of their vision is of the greatest importance for the Young or any other theory. The author gives most undue weight to colour diagrams. Colour triangles or circles are not intended to be the basis of a theory, but simply as illustration of it. It is quite possible that Clerk Maxwell's diagrams would not tally with those based on Kœnig's observations, nor should they do so. In fact a diagram may be drawn to illustrate any theory, as the author himself has done to illustrate his own.

In animadverting on Clerk-Maxwell's colour equations, the author, it may be remarked, has himself made a mistake as regards certain reductions to be given to the intensities of different colours. The equations are right as they stand, when it is remembered that Maxwell chose to adopt certain arbitrary units which he carried throughout them all.

The author in one place endeavours to prove the superiority of a 5-colour theory over a 3- or 4-colour theory, by narrating what is seen when a spectrum is formed with—what comes to—a very wide slit to the collimator. Practically he shows that this wide slit may be supposed to be made up with narrow slits, and that the spectrum formed when the wide slit is used is made up by the overlapping of the spectrum formed from the narrow slits. He then adds up the colours (or colour sensations) as follows:—

$$\begin{array}{llllll} R— & G— & P & & & \\ & R— & G— & P & & \\ & & R— & G— & P & \\ & & & R— & G— & P \\ \hline R— & y— & W— & W— & b— & P \end{array}$$

With the 4-colour theory he has five rows for addition, and with the 5-colour theory he has six rows. The last gives as the result R—2O—3Y—4b—W—W—4pe—3B—2v—P, where red, orange, yellow, lemon, white, peacock, blue, violet, and purple are denoted by the letters used as the sum of the additions. He remarks "that the results obtained for the 3-colour and 4-colour theories do not agree with what is actually seen with a prism." We can well believe it! But why he confines the colours to be added up to the number of colours in the theory we are at a loss to understand. It may be taken for granted that in employing this method of proving a theory, that theory which annexes the greatest number of primary colours will give results which are closer to what is seen than even the 5-colour theory.

As to the experiments which are "new and important," there is no doubt that there is one which will prove to be highly important if it can be always repeated to give the same results under conditions which bear rigid examination. The experiment is described as follows:

> "Very many years ago I showed experiments with rotating discs, which proved that 'persistence' does not (at any rate, wholly) take place in the way previously supposed; in the retina, or in the individual parts sensitive, as I maintain, variably sensitive, to light and colours. In one of the experiments I refer to, a brightly coloured disc was covered by a black disc having sector-shaped openings, such as to render the entire disc area half black and half coloured. When the discs are rotated at a suitable speed, under a strong light, the entire rotating disc appears more brightly coloured than an entire disc placed near the rotating disc. Thus, the colour effect of a disc, half of which is covered by black sectors, is by rotation made equal to or greater than that of an entirely uncovered disc of the same colour."

This one experiment would have caused a good deal of anxiety to those who have been at work at the general theory of vision had they known of it. Fox Talbot, Plateau, and others would have had to amend their papers—for the "persistence of vision" would evidently not obey the law which they adopted after submitting it to such experimental proofs as they could devise. Other experiments which the author brings forward as confirmatory of the 5-colour theory, it seems to the writer can be equally well explained by the 3-sensation theory, and probably by that of Hering.

In conclusion, it seems safe to say that these two last rival theories have not been overthrown by the work under review. Both have their weak points, but the number of them has not been increased by the exponent of the 5-colour theory.

ELECTRICAL RULES AND TABLES.

A Pocket-book of Electrical Rules and Tables. By John Munro, C.E., and Andrew Jamieson, M.I.C.E., F.R.S.E., &c. Eighth Edition, Revised and Enlarged. (London: Griffin and Co., 1892.)

JUST eight years ago we reviewed the first edition of this electrical *vade mecum.* The fact that we have now to notice the eighth edition is abundant proof that it has been found of service by the electrical public. That it deserved well of those for whom it was compiled there can be no doubt. The authors have been most active in collecting information from all sources, and in extending the work so as to keep the information contained in it fairly representative of the current state of industrial electricity. Since the first edition it has been almost doubled in size, and much very important matter has thereby been added.

A special feature of the book as it now stands is the short accounts of various branches of electrical engineering which have been contributed by specialists. Such are Dr. Thompson's chapter on dynamo machinery, Mr. Kapp's account of transformers, and Prof. Ewing's sketch of magnetic measurements. These are very valuable, and add much to the authoritative character of the work as a guide to engineers more especially concerned with electric lighting and transmission of power.

When the first edition appeared we noticed a number of points in which we thought the book required amendment. Looking over the present edition, we have been struck with the very considerable improvement which has been effected in point of precision and accuracy. But we have again met with some passages in which we fancy the work may be still further improved.

First, on p. 10, we were not able to see before, and we do not see yet, what the fact that the dimensions of resistance in electromagnetic units are those of velocity, has by itself to do with the velocity v, which is the ratio of the electromagnetic to the electrostatic unit of quantity of electricity.

At p. 15 it might have been well to mention the convergence of all the latest absolute determinations of the ohm upon something like 106·3 cms. as the length of the column of mercury, representing it according to the usual specification.

At p. 42 definitions of the pound avoirdupois and standard kilogramme are given, in which the precise temperature and pressure of the atmosphere at which the weights of the standard lumps of platinum are a pound and a kilogramme respectively are carefully specified! We should like to know why there is not a reference to the hygrometric state of the atmosphere as well!

With regard to the statement with respect to density, at p. 43, it is not usual, we think, to define density otherwise than as mass per unit of volume. It is therefore a quantity of dimensions ML^{-3}, whereas specific gravity is a mere numeric. In cases in which specific gravity and density are numerically the same, there is still this essential difference in nature between the two quantities.

Of course, the same word *density* is used in a peculiar sense, frequently, when applied to gases, and our experience shows that nothing has a more confusing effect in the mind of an elementary student of physics and chemistry than this double use of the word. It would be well to insist, as is often done by careful teachers, that it is *relative density* that is here meant, and not density in the ordinary sense.

With respect to the velocity of sound in air (p. 50) it might be as well to notice that it depends upon the temperature of the air.

At p. 127, under the heading "Impedance," impedance in its proper technical sense as $\sqrt{R^2 + n^2L^2}$ is not defined. The definition is given elsewhere in the book, but there is no clue to it in the index. In the last formula the exponential ϵ has fallen out from before its exponent. Here we might remark that in a book of this kind, where space is of great importance, and especially with such lumbering exponents as $-\frac{RT}{L_s}$ the use of the *solidus* notation would be a great improvement.

The authors will not think us inappreciative in making these remarks. In a work dealing with such a multifarious set of topics it is difficult even in several editions to completely eliminate error, and we have made these notes (and some others) in case the authors may care to make use of them. As we have said, the book is a useful and handy synopsis of electrical information of all kinds, and is very worthy to take the place which it seems is being accorded to it, of the electrical *Molesworth.*

G.

THE MOTHS OF THE WORLD.

A Synonymic Catalogue of Lepidoptera Heterocera (*Moths*). By W. F. Kirby, F.L.S., F.E.S., &c. Vol. I. Sphinges and Bombyces. (London: Gurney and Jackson, 1892.)

THE publication of the first volume of Mr. Kirby's Catalogue of Heterocera cannot fail to be regarded as a great event amongst students of exotic moths, and should mark an epoch from which is to commence the great work of reducing the vast amount of material they have to deal with to some kind of system and order, from the state of chaos produced by the greater number of those who have taken up the subject continuing to describe innumerable species, forms, and varieties, without any systematic study or attempt to define the limits of the families and genera they placed them in. So vast and scattered was the literature on the subject that it was almost hopeless to attempt to discover even how many species had been described in any given genus, or to say with any certainty that the forms to be dealt with had not been described by other authors; and if the subject in hand was the study of a local fauna, and not the monographing of a group, the only plan it was possible to adopt was to place the species in approximately the right genus and trust more or less to chance, according to the availability of large collections for consultation, that they had not been described elsewhere. Students will now have no such excuse for inexact work, and, up to the end of the numerous and very remotely connected groups of families known as the Bombyces, will have a complete and easily consulted catalogue of all described species, with the localities they come from, so that they will be able to see at a glance to which species the forms they are trying to identify are most likely to belong, and having full references to the books in which they are described their labours will be lightened by almost half, as students of the European fauna who have had Staudinger's catalogue to help them will fully appreciate. No one but Mr. Kirby who has lived his life among the books on the subject, and has been collecting his materials for the last twenty years, as he tells us in his preface, could have made the catalogue as complete as he has done, and though it is of course impossible that such a volume could have been put together without a few errors and omissions creeping in, yet some months of work with the advantage of being constantly able to borrow the proof sheets has shown how extremely few these are.

As the arrangement adopted is in the main that of the British Museum, or of some well known and approved works on special groups, and as there is also an index to the genera, there should be no real difficulty in finding the species required; and since the complete index to species and genera will take up one out of the five volumes required to complete the catalogue, it is obviously impossible that there should be a specific index to each volume. It is to be hoped that Mr. Kirby will be able to bring out the other volumes within the next two or three years, and will receive the support of all those interested in the subject. This, indeed, he can hardly fail to do, as they will find themselves quite unable to get on without his catalogue when once accustomed to the use of it. The marking of the type of each genus by an asterisk is an addition of very great value, as compared to the catalogue of Rhopalocera by the same author; and the only serious fault to be found with the book is the upsetting of many well-known names by the adoption of Hübnerian genera, and in especial those of the "Tentamen," a mere hand-list of names for that author's private use, and never published or intended to be published, and in accepting which Mr. Kirby will find hardly a single lepidopterist to follow him. Hübner's "Verzicknitz" stands on rather different grounds; but even that work is merely a childish collection of names, the species being classified into very heterogeneous groups solely by colour and pattern, and since the divisions which subsequent authors have been pleased to term his genera, though that name might equally well be applied to other of his sections, are neither defined nor the types indicated, it is placed out of Court according to the British Association rules; then again a few well-known generic names, such as *Cossus*, are upset as having previously been used in a specific sense. If these principles were adopted and pushed to their logical conclusion every family of Rhopalocera would have to be re-named and innumerable other changes made, so that nomenclature would be vastly more confusing than it is even now, and the whole subject made unintelligible except to the few who had leisure to make a special study of it. The classification adopted is in the main admirable; the *Castniidæ*, however, should perhaps be placed much lower in the scale; the *Uraniidæ* are rightly disassociated from the *Geometridæ*, of which they have hitherto been placed as a subfamily, but a better arrangement would have been to have included in the family the genus *Micronia* and allies, and to have placed it next to the *Epiplemidæ* (*Erosiidæ* auctorum) and the *Geometridæ;* but these are facts of very recent recognition. The *Agaristidæ* again would come better next the *Noctuidæ*, from which they are hardly separable, and the *Syntomidæ*, which Mr. Kirby calls the *Zygæninæ*, are more usually separated from the *Zygænidæ*, of which the *Chalcosiinæ* and *Thymarinæ* are considered sub-families. Then again the *Lithosiinæ Nyctemerinæ* and the *Nycteolinæ* (here called *Cymbidæ*) are at most sub-families of the *Arctiidæ;* and the *Sphingidæ*, which are very rightly placed next the *Notodontidæ*, should have been preceded by a family composed of the genus *Eupterote* and allies which are still confounded with the *Lasiocampidæ*, a family with which they have little or nothing in common. All these, however, are matters of very secondary importance, and the catalogue amply fulfils the one thing required of it that it should be as complete and the references as correct as possible.

G. F. H.

OUR BOOK SHELF.

Grasses. By C. H. Johns, M.A. 96 pp. (S.P.C.K.)

THIS is a separately published appendix to the late Rev. C. H. Johns's "Flowers of the Field." In its present handy form it will be acceptable to students who wish to study more minutely our common grasses.

The first three pages are devoted to general remarks on Order Gramineæ. On p. 3 a list of the best fodder grasses of Europe is given; *Alopecurus pratensis*, a very valuable and generally useful grass, is omitted, whilst

Cynosurus cristatus is included. This latter species is of limited value, and in permanent pasture only.

Genera are given pp. 4-11, and the following fifty pages are occupied by an account of those species which have up to the present been found in Great Britain or Ireland. The rest of the book is devoted to the sedges. The derivations of the names of genera are mostly given, as well as the French and German synonyms of the different species discussed. The illustrations are satisfactory, and are in general given for those species which are most common. That of *Triticum repens*, on p. 32, is perhaps exceptional. The beginner very often confuses the spike of this grass with that of some varieties of rye-grass. The spikelets of the latter are set edgewise to the rachis, whilst those of the former have their flat sides to the rachis; if the beginner is still in doubt the rootstock can be examined; this is stoloniferous in the case of couch-grass.

Elementary Plane Trigonometry. Clarendon Press Series. By R. C. J. Nixon, M.A. (Clarendon Press, Oxford, 1892.)

THE author in his preface informs us that in writing this book he has tried to free his mind as far as possible from all current text-books, and to base this one solely on his experience of twenty-five years. That he has done this is soon seen when glancing through the pages, for the order of arrangement and general basis differ very considerably from those usually adopted. The line of demarcation he draws between elementary and higher works lies in the use and non-use of the symbol $\sqrt{-1}$, thus avoiding here altogether the use of imaginaries. An omission which may seem rather questionable is that of the theory of logarithms, which is here excluded as it does not appertain to trigonometry proper; the beginner is not left entirely without logarithms themselves, for there are two chapters in which he can make a slight acquaintance with them, together with one on the adaptation of formulæ to logarithmic calculation. Throughout the work the author has made a strong point of giving in their fulness and generality all definitions and proofs, while he has added also numerous examples, some of which are worked out to serve as specimens, while others are accompanied with hints as to their solution.

If any fault be found in the book it is perhaps that it has been expanded to too great dimensions: excluding the answers at the end there are no less than 364 pages, which, for an elementary work of this kind, is undoubtedly a large number. At any rate the error is made on the right side. In all other respects the book can be decidedly recommended, for the propositions are all neatly proved, and the get-up, as regards the figures and letters, could scarcely be surpassed.

Paraguay: The Land and the People, Natural Wealth and Commercial Capabilities. By Dr. E. de Bourgade La Dardye. English Edition. Edited by E. G. Ravenstein. (London: George Philip and Son, 1892.)

EVERY one who has any reason to be interested in Paraguay ought to read this book, which is in most respects a model of what such a work ought to be. The author spent two years in the country, so that he had ample opportunities for making himself acquainted with its leading characteristics. His impressions, upon the whole, were very favourable; but there is not the faintest attempt to convey an exaggerated idea either of Paraguay's resources or of the use she is making of them. M. de Bourgade writes in a spirit of scientific impartiality, bringing out the facts exactly in accordance with what he believes to be the most trustworthy evidence. He begins with an account of the geographical exploration of the country, then presents a geological survey, and describes the basins of the Parana and the Paraguay, and Paraguay's vegetable and animal life and minerals. Next there are chapters on various aspects of social life—government, and laws, financial position, real property, population, and immigration. A section on "Labour" includes chapters on means of communication, the soil, stock-breeding, agricultural products, tobacco, timber, textile plants, various raw materials, yerba-maté, and the orange. On all these subjects the author writes clearly and with full information. The work is enriched with a map and illustrations, and of the translation we need only say that it has been done carefully and adequately.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Thunderstorms and Sunspots.

ABOUT six years ago Prof. von Bezold laid before the Bavarian Academy a memoir relating to lightning-flashes that had done damage to houses in Bavaria. In that kingdom the fire-insurance of buildings is entirely in the hands of the State, and a long series of statistical data on the subject was available.

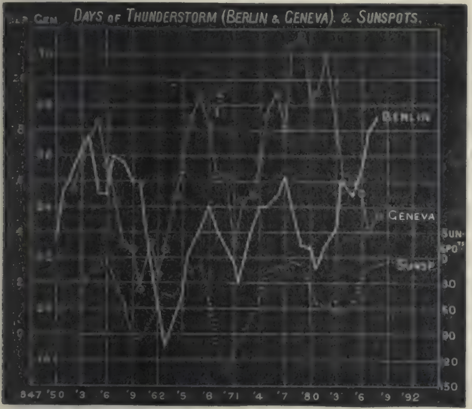
Two things appeared from this inquiry—first, that those damaging lightning-flashes had enormously increased in the last fifty years (to 1882), much more than the increase of houses; and second, that there was apparently some relation between the phenomena and the sunspot cycle. To each maximum of sunspots corresponded a minimum of damaging lightning-flashes or thunderstorms (only in two cases one year displaced); but between each pair of minima was another secondary minimum not far from the minimum of sunspots. The curve of lightning damage, in fact, shows a double oscillation for each sunspot period, maxima of sunspots corresponding with the better-defined of the two minima of lightning damage. A somewhat similar result had been arrived at by Prof. Fritz from a study of thunderstorms in the Indian Archipelago, but he considered it adverse to the idea of a causal relation between sunspots and thunderstorms.

In an earlier paper to the Bavarian Academy (1874), Prof. von Bezold, from a study of several thunderstorm records, came to the conclusion that "high temperatures and a spotless solar surface give years abounding in thunderstorms." This supposed relation between sunspots and thunderstorms does not seem to have attracted much attention of late years. The object of this note is chiefly to show some curves and figures from thunderstorm records, which, it appears to me, yield further evidence of the relation.

In the diagram herewith are two curves, one for Berlin from 1850, the other for Geneva from 1852. The numbers of days of observed thunder are taken and grouped in averages, each yearly point of the curve representing an average of five years. The vertical scale-figures are to the left. Below is an inverted sunspot curve, with scale-figures to the right. The upper points of the latter are minima, and it will be observed how maxima of the thunderstorm curves occur over them or nearly so; and similarly with sunspot maxima and minima of the other curves. There is not always exact coincidence, but a very considerable correspondence will be noticed. (I do not here reproduce the figures yielding those curves.)

It is to be regretted that the official Greenwich records do not, so far as I know, contain any tabulated series of figures relating to thunderstorms in a long course of years. From an examination of the *Greenwich Observations* and the *Weekly Return*, I am enabled to present a table of the number of days on which thunder was observed during the six months April to September in each year from 1850 to 1891. The actual figures are given in one column, and another column gives smoothed values (five year averages). In the curve made from these smooth values, we find maxima corresponding closely with the sunspot minima of 1856 and 1878, and it is now, apparently, near another pronounced maximum which would correspond with the sunspot minimum of 1889 (I may mention that the number of thunder days this year is, thus far, small, and the smoothed curve seems likely to go down). The sunspot minimum of 1867 seems not to be represented in the curve.

Whether or not we may regard this curve as lending support to the view in question, it may at least prove interesting to observe how our summer thunderstorms have varied in number of late years. The Thunderstorm Committee of the Royal Meteorological Society have not yet, I understand, attacked the question of a possible relation to sunspots. May it not be said, however, that the field looks promising?



While some other Continental records of thunderstorms treated in the same way yield results similar to those for Berlin and Geneva, there are some which cannot be said to support the view under consideration (though also not positively against it). When one reflects on the unsatisfactory nature of many thunderstorm records extending over a long series of years, vitiated by such things as a change of observers, or of the mode of observation or of record, &c., this need hardly be thought surprising.

Year.	Greenwich. Days Thunder (Apr.–Sept.).	Smoothed Values.	Year.	Greenwich. Days Thunder (Apr.–Sept.).	Smoothed Values.
1850	8	—	1871	12	10·4
1851	9	—	1872	17	11·8
1852	11	9·6	1873	9	12·2
1853	11	10·2	1874	12	12·0
1854	9	10·4	1875	11	11·0
1855	11	10·6	1876	11	14·4
1856*	10	11·4	1877	12	14·6
1857	12	12·6*	1878*	26	17·2*
1858	15	12·2	1879	13	16·8
1859	15	12·4	1880	24	15·6
1860	9	11·2	1881	9	13·6
1861	11	9·4	1882	6	13·2
1862	6	7·8	1883	16	11·0
1863	6	8·6	1884	11	10·8
1864	7	7·6	1885	13	10·8
1865	13	9·0	1886	8	11·4
1866	6	9·8	1887	6	13·8
1867*	13	9·4	1888	19	13·8
1868	10	8·6	1889*	23	16·2*
1869	5	9·8	1890	13	—
1870	9	10·6	1891	20	—

Minimum sunspots and maximum thunder days (smoothed values) indicated by an asterisk.

A. B. M.

The Nova Aurigæ.

THE Nova Aurigæ was observed on the night of September 14, with the Newall telescope, under favourable circumstances. It was almost exactly equal in brightness with the star 85″ nf; which of the two was brighter it was difficult to say, because of a peculiarity noted below, but its magnitude may be taken as close upon 10·3.

The spectrum, as seen with a compound prism between eye and eye-piece, showed a very faint continuous spectrum, varying from C to F (or? G);

> a bright line quite, or nearly, coincident with C;
> three bright lines close together in the green, the least refrangible one seeming considerably broader than the others;
> a faint bright line in the blue (? F);

and with great difficulty I saw at times a still fainter line in the violet. I failed to make out that the bright lines had the dark companions seen in the spring. At first sight the spectrum seemed to consist of a single broad bright line in the green.

With a power of 215 (without spectroscope) I at first thought that the Nova was diffuse, and resembled a minute planetary nebula rather than a star; but on focussing more carefully, I made out that the Nova was distinctly stellar; now, however, the neighbouring stars resembled planetary nebulæ. In fact the Nova and neighbouring stars could not be focussed simultaneously. With a power 500 the effect was of course more marked. The Nova owes its visual magnitude nearly entirely to the light that gives rise to the three green lines in the spectrum, and it is interesting to note that it was possible to verify a conclusion drawn from this fact and from the nature of the chromatic dispersion of a refractor of 29 feet focal length:—the image of the Nova was distinctly more point-like than that of the neighbouring equally bright star, when each in turn was focussed as carefully as possible. H. F. NEWALL.

Ferndene, Gateshead-on-Tyne.

Atmospheric Depressions and their Analogy with the Movements of Sunspots.

A SOMEWHAT prolonged absence from home has prevented me seeing until now your note on July 21, page 280, in which the writer remarks that the results of M. Camille Flammarion—published in the July number of *L'Astronomie*—"seem to confirm the view suggested by M. Faye that the constitution of [sun] spots resembles somewhat that of the cyclones with which we are familiar."

I write to point out that this is not the theory of M. Faye, but, on the contrary, is the theory of Mr. Herbert Spencer, which he published in the *Reader* for February 25, 1865, and which has since been republished in his collected essays under the title, "The Constitution of the Sun." In it Mr. Spencer first points out the untenability of M. Faye's hypothesis, and then goes on to say:—"The explanation of the solar spots above suggested, which was originally propounded in opposition to that of M. Faye, was eventually adopted by him in place of his own. In the *Comptes Rendus* for 1867, vol. lxiv., p. 404, he refers to the article in the *Reader*, partly reproduced above, and speaks of me as having been replied to in a previous note. Again, in the *Comptes Rendus* for 1872, vol. lxxv., p. 1664, he recognizes the inadequacy of his hypothesis, saying:—'Il est certain que l'objection de M. Spencer, reproduit et développée par M. Kirchoff, est fondée jusqu'à un certain point; l'intérieur des taches, si ce sont des lacunes dans la photosphère, doit être froid relativement . . . . Il est donc impossible qu'elles proviennent d'éruptions ascendantes.' He then proceeds to set forth the hypothesis that the spots are caused by the precipitation of vapour in the interiors of cyclones. But though, as above shown, he refers to the objection made in the foregoing essay to his original hypothesis, and recognizes its cogency, he does not say that the hypothesis which he thereupon substitutes is also to be found in the foregoing essay. Nor does he intimate this in the elaborate paper on the subject read before the French Association for the Advancement of Science, and published in the *Revue Scientifique* for March 24, 1883. The result is that the hypothesis is now currently ascribed to him. I should add that, while M. Faye ascribes solar spots to clouds formed within cyclones, we differ concerning the nature of the cloud. I have argued that it is formed by rarefaction, and consequent refrigeration, of the metallic gases constituting the stratum in which the cyclone exists. He argues that it is formed within the mass of cooled hydrogen drawn from the chromosphere into the vortex of the cyclone. Speaking of the cyclones, he says:—'Dans leur embouchure évasée ils entraîneront l'hydrogène froid de la chromosphère, produisant partout sur leur trajet vertical un abaissement notable de température et une obscurité relative, due à l'opacité de l'hydrogène froid englouti' (*Revue Scientifique*, March 24, 1883). Considering the intense cold required to reduce hydrogen to the 'critical point,' it is a strong supposition that the motion given to it by fluid friction on entering the vortex of the cyclone, can produce a rotation, rarefaction, and cooling, great enough to produce precipitation in a region so intensely heated."—(*Essays*, 1891 Edition, vol. i., pp. 188–9.)

Churchfield, Edgbaston. F. HOWARD COLLINS.

Direct Determination of the Gravitative Constant by Means of a Tuning-fork. A Lecture-Experiment.

THE following direct experiment for finding the value of the constant g has proved an instructive one for use with students beginning dynamics, and combines extreme simplicity with greater accuracy than might be anticipated.

A rectangular strip of thick plate-glass with one face lightly smoked is dropped past the end of a sounding tuning-fork of known pitch, and which, by means of a light attached style, traces on the smoked surface a fine rippling line whose undulations give a complete record of the relative motion. From measurements of such a trace the value of g can be determined immediately with an error of not more than $\frac{1}{2}$ per cent.

For let l_1 and l_2 be the distances fallen through in two equal consecutive intervals of time (t). Then $\frac{l_1}{t}$ and $\frac{l_2}{t}$ are the velocities at the middles of these two intervals, and $\frac{l_2 - l_1}{t}$ is therefore the velocity gained in time t, and $\frac{l_2 - l_1}{t^2}$ is the acceleration.

With a fork giving 384 complete oscillations per second it was found convenient to take for t the time of 30 oscillations; l_1 is then the length of any 30 consecutive waves and l_2 that of the next 30. These lengths were measured by means of a millimetre scale printed on card and held against the trace, tenths of a millimetre being estimated. The value of the difference ($l_2 - l_1$) was thus determined from several measures made in different parts of the trace, and, after some preliminary trials, it was found that such measures seldom differed by more than $\frac{1}{2}$ per cent. from their mean, and that the means of different traces agreed about equally well among themselves. Under the given conditions ($l_2 - l_1$) is just under 6 centimetres. The experiment takes only a moment to perform, and the plate can be at once exhibited as a lantern slide.

In order to obtain good traces a little care must be exercised. The smoking should be very light. A fine bristle from a clothes- or hearth-brush, 2 to 4 cm. long, stuck on with a scrap of wax, may be used as a style, and it should be inclined downwards so as to make an angle of 45° or less with the vertical face of the plate and project well under the plate before this is let fall, so as to be considerably bent while tracing. By furnishing each prong with such a bristle two simultaneous tracings are obtained. Although the method is independent of the actual velocity with which the plate reaches the style, yet it is best to let the plate fall from quite close above the end of the style (within, say, 1 cm.), so that as many wave-lengths as possible may be marked on the plate. The fork also should be strongly bowed with a violin bow, so as to give sharply accentuated ripples, the positions of whose crests are defined with greater precision than would be those of gentler undulations. The plate itself can be conveniently let go if the upper part of its suspension is a single string with a knot at the top, and to prevent its swinging in the air or turning as it descends, it may be held against a narrow smooth backing of hard wood. Without these precautions the trace is liable to show curvature and other irregularities, and indeed under any circumstances the first one or two undulations traced near the advancing edge of the plate are liable to be irregular. The more massive the plate the less is its motion affected by the pressure of the tracing style.

Although as a means of finding the value of g such a method does not compare for accuracy with the use of a pendulum, yet for the converse process of determining the pitch of a fork from measures of its trace and the known value of g, it may be of utility; for, since the length ($l_2 - l_1$) is proportional to the *square* of the vibration-number, the percentage error will now be halved or reduced to about 1 in 400, and I have little doubt that a careful experimenter, by attending to the causes of error, might further improve on this. A. M. WORTHINGTON.

R.N.E. College, Devonport, September 12.

A Meteor.

ON Wednesday, September 14, at 7h. 9m. p.m. a large meteor was seen by about twenty people, including myself, who were driving from Penmaenmawr to Conway. It was first observed in the south-east just above the Conway mountain. It was visible for about 30°, fell very slowly in a wavy line inclined at a small angle to the horizon, disappearing behind the mountain. It seemed to be very near the ground as it passed over the mountain.

The sky was quite bright, so that only Mars was clearly visible in it. The meteor appeared to the eye about the size and brightness of Jupiter at the present time, and was of a slightly bluer tint than that planet. There was no perceptible variation in size and brilliance while the meteor was in sight.

September 19. GRACE E. CHISHOLM.

Crater-like Depression in Glaciers.

A PROPOS de la cavité du glacier de Tête Rousse que M. Vallot et moi avons découverte et dont vous parlez dans NATURE (September 1), M. R. von Lendenfeld vous écrit (NATURE, September 15) qu'il a trouvé des dépressions cratériformes sur le glacier de Tasman, dans la Nouvelle Zélande. Permettez-moi de vous signaler que de pareilles dépressions existent sur certains glaciers des Alpes et notamment sur le glacier de Gorner, où la carte suisse en indique 26. Elles sont en général à peu près circulaires; leur plus grande dimension horizontale atteint parfois 130 mètres et leur profondeur 30 mètres. L'inclinaison de leurs parois varie en général de 45° à la verticale. Elles reçoivent souvent de l'eau qui s'engouffre au fond dans un moulin ou qui s'écoule, par une crevasse, dans une dépression voisine. Au mois d'août dernier, l'une d'elles formait un véritable petit lac glaciaire que j'ai sondé avec M. Etienne Ritter au moyen d'un bateau démontable; la profondeur de l'eau était presque partout de 5 à 6 mètres, sauf dans un trou, vraisemblablement un moulin, où ma sonde est descendue jusqu'à 21 mètres. Il est probable que, lorsque la pression de l'eau aura élargi le moulin par où elle s'écoule, la cavité se videra.

Les dépressions ne me paraissent avoir aucune analogie avec la cavité que j'ai vue à Tête Rousse. Leur origine est assez mal connue (voir Heim, "Gletscherkunde," p. 246); il est possible, comme le pensait primitivement votre honorable correspondant, qu'elles soient d'anciens moulins transformés.

J'en ai vu une également sur la Mer de Glace, entre le Montanvers et le Tacul.

L'étude de ces dépressions, encore très incomplète, serait très intéressante, et je les signale à l'attention de ceux qui parcourent les glaciers.

Veuillez agréer, monsieur, mes civilités empressées.

Thonon, le 17 Septembre. ANDRÉ DELEBECQUE.

GENERALIZATION OF "MERCATOR'S" PROJECTION PERFORMED BY AID OF ELECTRICAL INSTRUMENTS.

THE following mode of generalizing Mercator's Projection is merely an illustration of a communication to Section A of the British Association at its recent meeting in Edinburgh, entitled "Reduction of every Problem of Two Freedoms in Conservative Dynamics to the Drawing of Geodetic Lines on a Surface of given Specific Curvature." An abstract of this paper appeared in NATURE for August 18.

In 1568, Gerhard Krämer, commonly known as "Mercator" (the Latin of his surname), gave to the world his chart, now of universal use in navigation. In it every island, every bay, every cape, every coast-line, if not extending over more than two or three degrees of longitude, or farther north and south than a distance equal to two or three degrees of longitude, is shown very approximately in its true shape: rigorously so if it extends over distances equal only to an infinitesimal difference of longitude. The angle between any two intersecting lines on the surface of the globe is reproduced rigorously without change in the corresponding angle on the chart.

Mercator's chart may be imagined as being made by coating the whole surface of a globe with a thin inextensible sheet of matter—sheet india-rubber for example (for simplicity, however, imagined to be perfectly extensible but inelastic)—cutting away two polar circles to be omitted from the chart; cutting the sheet through along a meridian, that of 180° longitude from Greenwich for example, stretching the sheet everywhere except along the equator so as to make all the circles of latitude equal in length to the circumference of the equator, and stretching the sheet in the direction of the meridian in the same ratio as the ratio in which the circles of latitude are stretched, while keeping at right angles the intersections between the meridians and the parallels. The sheet thus altered may be laid out flat or rolled up, as a paper chart.

What I call a generalized Mercator's chart for a body of any shape spherical or non-spherical, is a flat sheet showing for any intersecting lines that can be drawn on a part of the surface of the body, corresponding lines which intersect at the same angles. One Mercator chart of finite dimensions can only represent a part of the complete surface of a finite body, if the body be simply continuous; that is to say, if it has no hole or tunnel through it. The whole surface of an anchor ring can obviously be mercatorized on one chart. It is easily seen, for the case of the globe, that two charts suffice to mercatorize the whole surface; and it will be proved presently that three charts suffice for any simply continuous closed surface, however extremely it may deviate from the spherical form.

In "Liouville's Journal" for 1847, its editor, Liouville, gave an analytical investigation, according to which, if the equation of any surface whatever is given, a set of lines drawn on it can be found to fulfil the condition that the surface can be divided into infinitesimal squares by these lines and the set of lines on the surface which cut them at right angles. Now it is clear that if we have any portion of a curved surface thus divided into infinitesimal square allotments, that is to say, divided into infinitesimal squares, with the corners of four squares together, all through it, we can alter all these squares to one size and lay them down on a flat surface with each in contact with its four original neighbours; and thus the supposed portion of surface is mercatorized. Except for the case of a figure of revolution, or an ellipsoid, or virtually equivalent cases, Liouville's differential equations are of a very intractable kind. I have only recently noticed that we can solve the problem graphically (with any accuracy desired if the problem were a practical problem, which it is not) by aid of a voltmeter and a voltaic battery, or other means of producing electric currents, as follows:—

1. Construct the surface to be mercatorized in thin sheet metal of uniform thickness throughout. By thin I mean that the thickness is to be a small fraction of the smallest radius of curvature of any part of the surface.

2. Choose any two points of the surface, N, S, and apply the electrodes of a battery to it at these points.

3. By aid of movable electrodes of the voltmeter, trace an equipotential line, E, as close as may be around one electrode, and another equipotential line, F, as near as may be around the other electrode. Between these two equipotentials, E, F, trace a large number, n, of equidifferent equipotentials. Divide any one of the equipotentials into n equal parts; and through the divisional points draw lines cutting the whole series of equipotentials at right angles. These transverse lines and the equipotentials divide the whole surface between E and F into infinitesimal squares (Maxwell, "Electricity and Magnetism," § 651).

4. Alter all the squares to one size and place them together, as explained above. Thus we have a Mercator chart of the whole surface between E and F.

N and S of our generalization correspond to the north and south poles of Mercator's chart of the world; and our generalized rule shows that a chart fulfilling the essential principle of similarity realized by Mercator may be constructed for a spherical surface by choosing for N, S any two points not necessarily the poles at the extremities of a diameter. If the points N, S are infinitely near one another, the resulting Mercator chart for the case of a spherical surface, is the stereographic projection of the surface on the tangent plane at the opposite end of the diameter through the point, C, midway between N and S. In this case the equipotentials and the stream-lines are circles on the spherical surface cutting N S at right angles, and touching it, respectively.

For a spherical or any other surface we may mercatorize any rectangular portion of it, A B C D, bounded by four curves, AB, BC, CD, DA, cutting one another at right angles as follows. Cut this part out of the complete metallic sheet; to two of its opposite edges, A B, D C, for instance, fix infinitely conductive borders. Apply the electrodes of a voltaic battery to these borders, and trace n equidifferent equipotential lines between AB and DC. Divide any one of these equipotentials into n equal parts, and through the divisional points draw curves cutting perpendicularly the whole series of equipotentials. These curves and the equipotentials divide the whole area into infinitesimal squares. Equalize the squares and lay them together on the flat as above.

If we have no mathematical instruments by which we can draw a system of curves at right angles to a system already drawn, we may dispense with mathematical instruments altogether, and complete the problem of dividing into squares by electrical instruments as follows: Remove the conducting borders from AB, DC; apply infinitely conductive borders to AD and BC, apply electrodes to these conducting borders, and as before draw n equidifferent equipotentials. This second set of equipotentials, and the first set, divide the whole area into squares.

KELVIN.

THE ACTIVE ALBUMEN IN PLANTS.[1]

ONE of the most important chemical functions of plant-cells is that synthesis of albuminous matter which serves for the formation of protoplasm. The *living* protoplasm, however, is composed of proteids entirely different from the ordinary soluble proteids, as well as from the proteids of *dead* protoplasm. In other words, if living protoplasm dies, the albuminous constituents change their chemical character. We observe that in the living state a faculty of antoxidation (respiration) exists, which is wanting in the dead condition; and Pflüger, in 1875, drew from this the conclusion that in protoplasm the chemical constitution of the living proteids changes at the moment of death.

Various other considerations force us to accept this logical conclusion. Chemical changes readily occur in all those organic compounds that are of a *labile* character. There exist so-called labile atom-constellations that are in lively motion, and are thus prone to undergo change, the atoms falling into new arrangements which present more stable constellations.[1] We do not doubt that *vital force is a mode of motion* due to the presence of atoms in labile positions in the albuminous substance. The motion ceases when there occurs a migration of the labile atoms to some stable position. The aldehydes give us fine illustrations of labile combinations and stable rearrangements in other allied substances.

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[1] This paper was read before the Liège meeting of the International Congress of Physiologists, of whose proceedings we gave some account last week.

The question now arises, can we chemically demonstrate that the albuminous substance formed by synthesis in plants is—*even before it has become protoplasm*—different from ordinary albumen? It was known long ago that the juice of plants—that is the aqueous solution in the vacuoles of the cells—contains albumen, but it was thought to be ordinary albumen. It is easy to prove that this is not the case.[2]

On treating living plant cells with dilute solutions of ammonia or organic bases or their salts, remarkable changes are observed. These consist either in the formation of numerous minute granules as is the case on the application of most of the bases, or in the production of little globules flowing together to make relatively large drops of a substance of high refractory power, as is the case on the application of weak bases like caffein or antipyrin.[3] These latter two bases in weak solution do not injuriously affect the protoplasm itself, since the cells will keep alive for a number of days in a 0·5 per cent. solution of these bases; the cells are, however, soon killed by other bases and their salts. The granules and globules formed in the living cells by the action of caffein have been called by Bokorny and myself *Proteosomes*. They give the principal reactions of albuminous bodies, but contain in most cases an admixture of small quantities of lecithin and tannin. These admixtures, however, can be removed by cultivating the objects (the alga, Spirogyra, for instance) in solutions rich in nitrates. If now by such cultivation the tannin has been removed and the proteosomes then produced by treatment with caffein, we can observe that these albuminous proteosomes are capable of reducing silver from even highly diluted alkaline solutions. This property is lost after treatment with dilute acids as well as after the death of the cells.[4] In these cases the proteosomes become hollow and turbid, their substance appearing to coagulate and shrink.

There are thus experimental grounds for the conclusion that not only the organized albumen of the living protoplasm, but also the albumen dissolved in the vacuoles—the unorganized albumen—is a different substance from the ordinary albumen, which is present in dead cells. We may sum up the line of argument as follows:—

I. Bases act upon the albumen of living cells; not, however, upon that of dead cells, nor upon ordinary dissolved albumen.

II. The action may be observed microscopically to take place in the case of various vegetable objects in the liquid portion of the protoplasm itself as well as in the vacuoles. This can be specially well observed with the alga Spirogyra when treated with caffein.

III. The granules and globules into which the active albumen aggregates by the action of bases—called by us proteosomes—have the property of reducing dilute silver solutions in the absence of light, and lose this property by the action of acids.

IV. The active albumen in its most *unchanged* condition can be made visible by caffein or antipyrin, two bases that do not act as serious poisons to the cells. Living cells containing proteosomes, brought out by caffein when placed in distilled water regain their original condition, the proteosomes become gradually dissolved again (rapidly at 25°C.), and a new application of caffein will now make them reappear.

V. If proteosomes are produced by caffein or antipyrin, and the death of the cells is then caused by ether vapour, &c., it may be easily observed that soon after the death of the protoplasm the proteosomes of the vacuoles are also changed in their optical and chemical properties; they become turbid and hollow, they coagulate, and they lose their property of being resoluble in distilled water.

O. LOEW.

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[1] Many examples can be cited from organic chemistry; for instance, the rapid change of the diamidoaceton as soon as it is liberated from its salts (Berichte d. Deutschen Chem. Ges. 25, 1563). Compare also the article, "Chemical Motions," Biolog. Centralblatt ix. N. 16.

[2] O. Loew und Th. Bokorny, Biolog. Centralblatt xi. 1.

[3] These globules closely resemble the aggregated masses that Darwin observed after irritation of leaves of Drosera.

[4] The proteosomes produced by ammonia and various other bases preserve this property for a much longer time after the death of the cell than those produced by caffein or antipyrin.

DISCOVERY OF A FIFTH SATELLITE TO JUPITER.

IN January of the year 1610 Galileo, at Padua, in Italy, discovered four satellites revolving round Jupiter, and though more than 282 years elapsed in the interval, from that time to August, 1892, no additional satellites were detected near this planet, and astronomers naturally inferred that no others existed. The fact that Jupiter possessed four satellites has become familiar to every schoolboy, for it has been repeated in all the astronomical text-books published during nearly three centuries. Few people therefore could have imagined that the statement would ever be controverted or rendered untenable by new discoveries. In regard to the more distant planets Uranus and Neptune, there was every prospect of additional satellites being detected, but with Jupiter the circumstances were somewhat different. The four satellites were so bright and so palpably visible in very small telescopes that it was scarcely thought possible that another existed small enough to remain unseen. Moreover, there was a significant agreement in the relatively increasing numbers of the satellites surrounding the planets Mars, Jupiter, and Saturn. Mars was known to have two satellites, Jupiter four, and Saturn eight, the number doubling itself with each step outward from the sun, and it was considered probable that the harmony of the series would not be disturbed.

Now, however, the astronomical world has been excited by the announcement that a new satellite has been discovered in attendance on Jupiter, and that its distance from the centre of the planet is 112,400 miles, and its period of revolution 17 hours 36 minutes. The discovery was effected by Prof. Barnard, of the Lick Observatory on Mount Hamilton in California, and, as he has already proved himself a very acute observer, especially of comets, and as he has the occasional use of what is supposed to be the most powerful telescope hitherto constructed, there is no good reason to discredit the intelligence.

People will be obviously led to ask how this new satellite managed to evade detection during nearly three centuries of diligent telescopic research. How was it that one at least of the host of observers who have studied this plane and his circling moons by means of powerful glasses, did not sight the tiny orb which has now revealed itself to the watchful American astronomer? We imagine that the chief reason for this want of success is to be found in the fact that the new orb is not brighter than the thirteenth magnitude, and that, being situated close to its primary, it would therefore, in ordinary instruments, be quite obliterated in the surrounding glare. But it is perhaps rather singular that it was not detected by its shadow, which would be projected on the disc of Jupiter whenever the satellite passed between the planet and the earth, and this would be of daily occurrence. At such a time the shadow would appear as a small, black, circular spot moving rapidly from east to west across the disc, and with greater apparent velocity than the visible markings. And it is quite possible that the shadow has been observed on more than one occasion, but mistaken for an ordinary spot on the surface of Jupiter.

A curious fact in connection with the new satellite is its diminutive size as compared with the four others discovered by Galileo in 1610. But there is a similar disparity in the dimensions of the satellites of Saturn, and in proof of this we have only to compare the bright *Titan* with the excessively faint *Mimas* and *Hyperion.* Small as it is, however, it is certain that this new satellite of Jupiter is much larger than either of the two abnormally minute moons of Mars.

American astronomers are to be congratulated on this important discovery. Scientific activity in the United States has been rapidly developing in recent years, and this has been strikingly exemplified in the wide and attractive domain of astronomy. W. F. DENNING.

NOTES.

THE French Association for the Advancement of Science is holding at Pau its twenty-first annual meeting. The meeting began on Saturday last, when the members of the Association were cordially welcomed to Pau by the Mayor. The President, M. Collignon, delivered an address on the science and art of the engineer.

THE autumn meetings of the Iron and Steel Institute, under the presidency of Sir Frederick Abel, began at St. George's Hall, Liverpool, on Tuesday. At the opening meeting the President announced that the Council had elected Mr. Windsor Richards as his successor.

WE are glad to announce that a new Biological Laboratory is about to be established in the Calcutta Zoological Gardens. Babu Joy Gobinda Law, a member of one of the wealthy native families of Bengal, has offered R. 15,000 for the buildings and fittings of this institution. The primary object for which the Laboratory is founded is to investigate the action of snake-poison, and to discover, if possible, an antidote. The Laboratory will, however, also be used for anatomical and pathological researches, for which the rich material afforded by the animals in the gardens will be available.

THE Marine Biological Laboratory at Wood Hole, U.S., has been more successful this summer than in any previous year. During its season of work it had a corps of seventeen officers, instructors, and assistants, and an attendance of thirty-eight investigators and sixty-two elementary students.

WITH the designation of the Hopkins Seaside Laboratory, a marine biological laboratory has been established at Pacific Grove, California. We learn from the *Botanical Gazette* that, through the generosity of the Pacific Improvement Company, a piece of land has been furnished, and a sum granted sufficient to erect a plain frame building; and, by the liberality of Mr. Timothy Hopkins, provision is made for the equipment of the building, and for the further continuation and extension of the enterprise. An elementary course of lectures on marine botany was to be given during the present season.

THE weather during the past week was very fine and bright over the southern and eastern portions of the United Kingdom, until near the close of the period, when the type entirely changed, and thunderstorms, accompanied by heavy rain, occurred generally, but in the north and west the conditions were throughout far less settled. Cyclonic disturbances arrived on our coasts from the Atlantic with considerable frequency, and although they were for the most part slight and shallow, and unaccompanied by much wind, they were productive of a considerable quantity of rain. An important disturbance passed to the north of Scotland on Thursday night and during Friday, and was accompanied by strong gales on our north-west and north coasts. Temperatures were high for the season over the greater part of England, and on Monday the day readings in places were higher than at any time during the month, the shade thermometer registering 72° in London. Some nights, however, were exceptionally cold, the shade minimum between Saturday and Sunday falling to within one degree of the freezing point in the eastern part of England, while there was a sharp frost on the ground open to the sky. The *Weekly Weather Report*, issued on the 17th inst., shows that the rainfall exceeded the mean in the north and west of Scotland and in the north of Ireland. In all the other parts of the United Kingdom there was a deficit; in most of the English districts the fall was very slight.

THE Report of the Meteorological Commission for the year 1891 states that complete, or nearly complete, meteorological observations have been received from forty-nine stations, and that observations of rainfall have been furnished from 320 stations; the instruments are usually supplied by the Commission. The Report contains diagrams showing the mean monthly rainfall corrected to date at thirty-three stations, together with the abnormal falls in the years 1888 and 1891. The rainfall in 1891 has been excessive, especially over the eastern part of the colony and over the Orange Free State, where at some places it exceeded 12 inches above the average. The observer at Phillipolis states that hardly a farmer in that district but has lost one-third of his sheep, owing to the continued wet, and in some places the farmers have had to vacate their homes in consequence of the weather.

THE "Pilot Chart of the North Atlantic Ocean" for September contains tracks of the drift of the two parts of the derelict ship *Fred. B. Taylor*, which was cut in two by a collision on June 22, in lat. 40° 19′ N., long. 68° 33′ W. The forward and after parts separated, and drifted in entirely different directions, in a manner which is quite unprecedented in the history of shipwrecks. The after end was evidently influenced more by wind than the bow portion; the latter pursued a south-westerly course, which was attributable largely to the cold southerly current between the American coast and the Gulf Stream, and on August 26 had drifted to lat. 38° 40′, long. 73° 15′. The stern part took a direct northerly course until July 17, when it was ten miles north-west of Matinicus Island, whence it took a westerly course, and was cast ashore on August 7 on Wells Beach, near Cape Porpoise.

THE first annual convention of the American Association of State Weather Services was held at Rochester, N.Y., on August 15 and 16, in conjunction with the meeting of the American Association for the Advancement of Science, and was largely attended by representatives of the various States. The subject of thermometer exposure was discussed, and a committee was appointed to consider the most suitable form of shelter and manner of exposure to be adopted throughout the country. It was resolved that means should be deduced from self-registering instruments wherever practicable, in preference to the method of using eye observations. An interesting paper was read by W. L. Moore, of Wisconsin, on the forecasting of thunderstorms; and the question of the best methods of signalling weather forecasts, whether by flags, semaphores, spherical bodies hoisted on a staff, &c., was freely discussed, and a committee was appointed to report upon the subject at an early date. It was decided that each State service should have a separate exhibit at the World's Fair at Chicago, and not to have the exhibits collected in the building for the use of the United States Weather Bureau.

LAST year an Aino in the western part of the island of Yezo caught two bears, one of which was perfectly white. This capture created much excitement among the natives, as their chief god is a white bear, and he is supposed to dwell on an inaccessible mountain in the interior of the island, and never to let himself be seen by human beings. The Ainos, therefore, concluded that the young white bear was a sort of Messiah, and after long consideration they decided that he ought to be sent as a present to the Mikado. In due time he arrived at Tokio, and by the Mikado's orders he was received into the Zoological Garden. Here the animal soon became ill, and Herr J. L. Janson was requested to do what he could for it. Fortunately his treatment of it was successful. At first he thought the creature must be a polar bear; but he soon convinced himself that this was a mistake, and that it was in reality an albino. In the latest number of the "Mittheilungen der Deutschen Gesellschaft für Natur- und Völkerkunde Ostasiens in Tokio," Herr Janson gives a full account of the bear, and he adds some interesting facts as to the importance attributed to white animals generally, and especially to albinos, in Japan. The appearance of an albino is supposed to be a good omen for the reigning monarch. The reign of a sovereign may even be known by the name of a white animal. Thus the reign of one ancient Mikado is called "Hakuchi nenkan," the period of the white pheasant. That of another is "Haku hōō nenkan," the period of the white phœnix. The white fox is often mentioned in fables and temple-stories, and a white serpent always appears in pictures and plastic representations with Benten, the goddess of fortune. As in former times among the Greeks, Romans, Persians, and Scythians, so among the Japanese, horses dedicated to the gods were generally white; and white horses are still found in connection with all the larger temples, and take part in the great annual processions. The milk and butter derived from white cows were formerly held in high esteem as medicine.

Mr. F. W. Ward, formerly editor of the *Sydney Daily Telegraph*, has sent to the Agricultural Department of New South Wales a report on recent shipments of fruit from Cape Colony to London. The report is printed in the July number of the *Agricultural Gazette of New South Wales*, which recommends it as "worthy of careful perusal." The *Gazette* refers to the fact that good fruit-growing districts abound in Australia, and that no better fruit can be grown in South Africa than is now being produced in many districts of New South Wales. The chief mistake hitherto, it says, has been the growing of unsuitable varieties—unsuitable not alone for export, but even for ordinary home use. It adds that this defect is being rapidly remedied, and that many growers, who have gained experience by their own efforts, are settling down to the work with intelligent earnestness.

Writing of wild strawberries in Ceylon, Mr. Nock says in the *Ceylon Observer* that the species *Fragaria vesca*, which grows so luxuriantly and fruits so abundantly in Jamaica, is now growing wild in many places in the Nuwara Eliya district. If the soil in Ceylon were as good as it is in the Blue Mountains of Jamaica, and there was less Nilu (*Strobilanthes*), this strawberry would soon, he thinks, be as plentiful in the hill districts of Ceylon as it is there. When Mr. Nock was Superintendent of the Government Cinchona Plantation in Jamaica, he has given as many as twenty free tickets in one day to old women and children to gather strawberries among the Cinchona Plantations. He has known them gathered by the bushel, and carried twenty-two miles to the Kingston market, where they always commanded a good price. He adds that he has this year raised seedlings of six of the best English varieties, to which he intends to give a fair trial in the Nuwara Eliya district.

The University of Minnesota has begun the publication of a *Quarterly Bulletin*, under the management of a board of editors. The chief editor being Prof. Conway M'Millan, the professor of botany to the University, is a guarantee that the interests of science will not be neglected in the *Bulletin*; and the first number contains several items of information of interest to American botanists.

In the report of the Royal Botanic Garden, Calcutta, for the year 1891–92, it is shown that the year was one of great activity as regards outdoor operations. The abnormally dry season proved very trying to many exotics, and, though for a time all other work was suspended and the whole garden staff was employed only in watering plants, many casualties occurred, especially among the finer and rarer plants. The attention of the staff was as usual largely directed to the cultivation and distribution of plants of economic interest. The chief event of the year under this head was the introduction of the aloe, which yields "sisal hemp" (*Agave rigida*, var. *sisalana*). The Director of the Royal Gardens, Kew, in June 1891, kindly obtained a consignment of plants for the Calcutta Garden from Florida, and kept these at Kew till they were strong enough to stand the voyage to Calcutta. The boxes reached Calcutta on October 29, 1891; unfortunately a considerable percentage of the plants died on the way out, and it was necessary to nurse the survivors carefully before they could be distributed. Over 19,000 specimens were contributed to the Herbarium during the year from various sources; while the distribution of authentically-named specimens to other herbaria reached the high total of 10,505 sheets. The chief benefactor to the Calcutta Herbarium was again the Royal Herbarium, Kew, to the Director of which institution the Calcutta one "owes a debt that can never be repaid." Among other contributors was Baron von Mueller, who again sent a beautiful collection of Australian plants. The Herbarium was also greatly enriched by further accessions of Tibetan, Chinese, and Mexican specimens, and the Saharanpur Herbarium presented 954 plants from the north-west Himalaya. Dr. Prain visited the Andaman Islands, Mount Parashak, and the Khasia, and was thus enabled to add valuable collections. Much good work was also done by collectors employed by the Calcutta Garden.

In the second number of the *Journal of the Polynesian Society* Dr. A. Carroll, of Sydney, offers what he believes to be translations of some of the famous Easter Island inscriptions. He is of opinion that Easter Island was at one time occupied by a pre-Polynesian people from America, and that to them the inscriptions are to be attributed. "While engaged in studying the languages, histories, antiquities, and inscriptions of ancient American peoples," he says, "I came upon similarities to the Easter Island characters, &c.; with these as keys, discovered what certain groups expressed, and from these, proceeding upon the recognized methods of decipherment, succeeded in reading into the original languages, and from these translating into English these Easter Island inscriptions." This is very vague, and, until Dr. Carroll gives some more definite information as to his methods, his claim that "another ancient writing is deciphered" will seem somewhat extravagant. Among the other contents of the number are an interesting account of some stone implements from the Chatham Islands, by Mr. S. Percy Smith, and the first part of a history of the occupation of the Chatham Islands by the Maoris in 1835, by Mr. A. Shand. Mr. Shand's information has been derived from the Maoris themselves, many of those who supplied it having taken part in the transactions they described.

Mr. William Kent, writing in *Science* on the American Association for the Advancement of Science, complains that it does not adequately represent the scientific movement in the United States. He points out that while more than 2000 members attended the Edinburgh meeting of the British Association, there were not 500 members at the Rochester meeting of the American Association, and of this number New York State contributed far more than its quota. In proportion to its population, Ohio sent twice as many members as Pennsylvania, although its average distance from Rochester is greater. Moreover, the several branches of science are not equally represented. Mechanical and engineering science, which is developing in the country by leaps and bounds, sends to the Association only one-fourth as many members as chemistry, and one-eighth as many as biology. The physical sciences, Mr. Kent says, are "dwarfed by the natural sciences." This he attributes to the fact that those who devote themselves to applied science have so many societies of their own that they are diverted from and lose their interest in the American Association. In engineering there are four large national societies, the civil, the mechanical, the mining, and the electrical, besides numerous local societies, aggregating a membership of probably 5000 persons, not counting duplications of those who belong to two or more societies.

A MOVEMENT has been started in Melbourne for the passing of a law which may tend to prevent the wanton destruction of birds in Victoria. A deputation, organized by the Victoria Field Naturalists' Club and representing the Melbourne Royal Society, Royal Agricultural Society, Royal Horticultural Society, and Zoological and Acclimatization Society lately brought the subject under the notice of the Ministers of Customs. In introducing the deputation, Messrs. G. D. Carter and J. Bosisto dwelt upon the necessity of protecting insectivorous birds from the reckless and indiscriminate shooting which is now so prevalent, as well as human lives, which are frequently sacrificed to the inexperience of sportsmen. The imposition of a gun tax as a legitimate source of revenue was also suggested. Prof. Kernot (Royal Society), Mr. C. M. Officer (Zoological Society), and Mr. C. Draper (Royal Agricultural Society) also emphasized these views. Mr. F. Wisewould referred to the draft which had been drawn up by the sub-committee of the Field Naturalists' Club—a draft based upon similar Acts in England and some of the Australian colonies. A few new features had, however, been added, notably that which made it illegal for persons under the influence of liquor to carry firearms. It was also provided that under no circumstances should a licence be given for the use of swivel guns. In answer to the deputation the Minister said that he would take the draft bill which had been prepared into favourable consideration. He would have an amended draft drawn up and submitted to those interested before its introduction into Parliament. He was of opinion that a 5*s*. tax, as proposed, was not heavy enough, since it would be worth the while of those who let out guns to pay the tax themselves.

THE serum of blood used to be regarded as merely a nutritive liquid; but it has been found to play a more important part, being capable of killing disease-germs, and of destroying and dissolving the red blood corpuscles of other animals. These properties have been recently studied by Herr Buchner (*Münchener Med. Wochenschrift*). They are gradually lost when the liquid has been removed from the animal. They are also destroyed by heating half-an-hour to 52° to 55° C. (A dog's serum stops the amœba-like movements of white-corpuscles of another animal species without killing them: but this property is also lost by heating to 55°.) Light also stops both actions; and diffuse daylight more than direct sunlight. It is apparently albumens in the serum that are operative; but whether all the albuminoid constituents, or certain specific albumens, was not determined. It is remarkable that solution of the serum with a 0·7 per cent. solution of common salt does not spoil the action, whereas a similar dilution with pure water makes the serum nearly inactive. But serum thus made inactive with water recovers its properties if salt solution is added; and this is the case even when the serum has been kept in the active state for four to 24 hours in ice. Serum may also receive a 0·7 per cent. solution of potassium or lithium chloride, or various other salts of the fixed alkalis, without losing its germicide properties. Ammonium salts even stimulate the latter. Herr Buchner calls the albumens in question alexines (or protective matters); he supposes they have a like action on foreign cells generally. The serum of dogs and rabbits having been mixed, the power of both alexines was weakened, but those of the rabbit more than those of the dog (to typhus bacilli). After acting some time on each other the globulicide power was quite extinguished. The author finds in these facts an explanation of the antitoxical action of the serum of animals protected against disease.

ACCORDING to the *Revista Financiera Mexicana*, quoted in the current number of the *Board of Trade Journal*, a deposit of onyx of considerable importance has just been discovered in Mexico, about 50 kilometres south of El Paso. It is said to be of superior quality, with fine grain, and richly shaded with delicate and varied tints. Blocks of considerable dimensions can be easily extracted.

DR. MORRIS GIBBS writes to *Science* from Kalamazoo, Michigan, that in that State there are to his knowledge six species of birds which feed on acorns. Of these, the passenger-pigeon and mourning-dove swallow the acorn entire, with its shell intact, only removing the cup or rough outside covering. The white-bellied nut-hatch occasionally hoards the acorns away, and only draws on its store after some months, and when the firm shelly covering readily gives way to its sharp, prying bill. The other three are the well-known blue-jay, common crow-blackbird, and red-headed woodpecker. So far as he has been able to learn, these birds, except in rare instances, do not pick the acorns from the tree, but have to content themselves with the fallen fruit. The red-head, deigning to descend to the ground, seizes an acorn, and flying with it in its bill to a spot where there is a small cavity in the dead portion of a trunk, or to a crevice in the bark, immediately begins to hammer it with its sharp-pointed bill. In a couple of strokes, it has removed the outer shell or cup, and at once attacks the still green-coloured shell which directly surrounds the meat. The inside, or shell proper, quickly gives way, usually nearly in halves, and the woodpecker enjoys the kernel. The woodpeckers are as nearly strict insect-feeders as any birds in Michigan, unless an exception is made of the swifts and swallows, yet here is an instance of a varied diet. However, the red-head is quickly satisfied in the acorn line, and soon begins circling the trunk, or more often limbs, for his legitimate food. The blackbird confines himself to the ground in his efforts for acorn meats. Walking up sedately to an acorn, and making no effort to seize or confine it, it strikes savagely and almost aimlessly. Its bill frequently glances, and the splintered shell dances about, until at last a huge piece of the kernel is dragged out, after which the bird leaves for other quarters or begins on another acorn. The jay swoops down with flaunting blue wings, and, seizing the largest acorn on the ground, flies to the nearest convenient limb or to the decayed ridge-board of an adjacent building. There, firmly pressing the nut between his big, black feet, he hammers away with a vengeance, and quickly tears off nearly half of the shell, after which he proceeds to pick out the meat in small bits. The cup is often left nearly perfect, the jay never making an effort to secure the nut entire, which he could easily do. Walking under the oaks, one can readily tell whether the woodpeckers, blackbirds, or jays have been at work among the acorns, by the appearance of the mutilated shell-remains lying about.

THE following arrangements have been made for science lectures at the Royal Victoria Hall during October:—October 4, Sir John Lubbock on "Books." After the address he will present the prizes and certificates gained by students of the M. M. College, Prof. Foxwell in the chair. October 11, Mr. C. T. Dent (late President of the Alpine Club), on "The Alps in Winter." October 18, Mr. F. W. Rudler, on "Frost and Fire," with special reference to the flood at St. Gervais, and the eruption of Etna. October 25, Col. Swinhoe on "Some Curiosities in Nature."

LAST week we noted that Messrs. Macmillan and Co. had issued a new edition of "Arithmetic for Schools." This is the well-known work by Mr. Barnard Smith. The book has been revised and enlarged by Prof. W. H. H. Hudson.

MESSRS. GAUTHIER-VILLARS have issued "Bulles de Savon," a translation, by C. E. Guillaume, of Mr. Boys' little work on "Soap Bubbles." The translator, while reproducing the main features of the book, has, with the author's sanction, adapted it for the use of French readers. He has also incorporated an account of some new experiments which Mr. Boys has brought to his notice.

THE first number of a new German journal, which promises to be of considerable interest to non-professional students of science, has just been issued in Berlin, the publisher being R. Oppenheim. It is entitled *Natur und Haus*, and is edited by L. Staby and M. Hesdorffer. The articles are written in a popular style, and well illustrated.

THE additions to the Zoological Society's Gardens during the past week include a Mona Monkey (*Cercopithecus mona* ♀) from West Africa, presented by Col. Makins; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mrs. Palmer; a Vulpine Squirrel (*Sciurus vulpina* ♂) from North America, presented by the Hon. G. Carew; a Malayan Tapir (*Tapirus indicus* ♂) from Malacca, presented by Col. J. M. Jenkins; a Great Eagle Owl (*Bubo maximus*), European, presented by Commander Ernest Rason, R.N.; a Black-crested Cardinal (*Gubernatrix cristatella*) from South America, presented by the Rev. W. B. K. Frances; a Small Hill Mynah (*Gracula religiosa*) from India, presented by Mr. George Grigs; a Long-nosed Crocodile (*Crocodilus cataphractus*) from the River Juba, East Africa, presented by Capt. F. G. Dunbar, R.N.; two —— Tortoises (*Testudo* ——), five Cinixys (*Cinixys* ——), a Puff Adder (*Vipera arietans*) from East Africa, presented by Mr. D. Wilson; a Pig-tailed Monkey (*Macacus nemestrinus* ♂) from Java, a White-backed Piping Crow (*Gymnorhina leuconota*) from Australia, an Adorned Terrapin (*Clemmys ornata*) from North America, a Robben Island Snake (*Coronella phocarum*) from South Africa, deposited; a Red Kangaroo (*Macropus rufus* ♀), a Black-fronted Weaver Bird (*Hypotriorchis velatus*) bred in the gardens.

OUR ASTRONOMICAL COLUMN.

PROPOSED SCHOOL OF PRACTICAL ASTRONOMY.—Mr. H. C. Russell, Government Astronomer of New South Wales, in a paper read before the Royal Society of Tasmania, makes some very practicable, and what we think excellent, suggestions with respect to the disposal of the sum of money (£10,000) left by the late Mr. Leake for the foundation of a school of astronomy. The idea is for the Leake trustees to co-operate with the University of Tasmania, and in this way form a complete school in which both the theory and practice of astronomy should be dealt with simultaneously. In addition to the observatory being merely a school for students, Mr. Russell suggests that it should take up some special line of research, and proposes that of astronomical photography. This seems an excellent proposition. The work which such an observatory as this could do if thoroughly equipped with the necessary apparatus, would be very considerable, and the special advantages of climate and position, to say nothing of the unexplored state of the southern heavens, would soon render it of great importance. There is no doubt that we are not yet overburdened with a surplus of observatories in the southern hemisphere, for even now there is a doubt as to how the international photographic chart of the heavens shall be provided for in this region, three observatories which have undertaken the work having been unable to carry out their plans on account of the political troubles. Should this proposal be accepted, the new Leake Observatory will start under good auspices, as it will fill up a gap by taking in hand a share of the greatest modern astronomical enterprise.

DOUBLE STAR MEASURES.—Mr. S. W. Burnham, in *Astronomische Nachrichten*, Nos. 3113–14, gives a list of all the double star measures that he has made during the year 1891 with the 36-inch of the Lick Observatory. Most of the stars here included may be classed as difficult objects, being too close for any smaller aperture, and all of them more or less unequal. As Mr. Burnham tells us, many of the stars are taken from his own catalogues, it being rather important to measure them at this time, since several are in very rapid motion. Owing to the fact that some of these stars have not been measured since the time of their discovery, it is interesting to note the changes that have taken place. Observations of these have "shown some very remarkable changes, and have shown the existence of some of the most remarkable binary systems known." Measurements have also been made of some of the closest and most difficult binaries from the discoveries of Clark, Struve, and others. The epoch for the star places is as heretofore 1880.

COMET BROOKS (1882, AUGUST 27).—From *Edinburgh Circular*, No. 31, we make the following extract of the elements and ephemeris relating to the comet discovered by Mr. Brooks at Geneva on the 27th. The computations are based on four observations made between August 31 and September 5:—

Elements.

$$T = 1892 \text{ Dec. } 19{\cdot}727 \text{ M.T. Berlin.}$$

$$\left.\begin{array}{rcl} \omega & = & 269^\circ\ 24'\ 27'' \\ \Omega & = & 261\ \ \ 2\ \ 55 \\ i & = & 27\ \ 57\ \ \ 8 \end{array}\right\}\text{Mean Equator, } 1892{\cdot}0.$$

$$\text{Log } q = 9{\cdot}84455.$$

Ephemeris for Berlin Midnight.

1892.	R.A. h. m. s.	Decl. ° ′	log. Δ.	log. r.	Br.
Sept. 21	7 2 13	+28 41·6	0·2342	0·2458	2·5
23	7 8 13	28 14·5			
25	7 14 21	27 45·0	0·2105	0·2315	3·0
27	7 20 37	27 13·1			
29	7 27 2	26 38·6	0·1860	0·2166	3·6

The brightness at the time of discovery is taken, as usual, as the unit of Br.

NOVA AURIGÆ.—Some short notes with regard to Nova Aurigæ are communicated to *Astronomische Nachrichten*, No. 3114, which may be of interest here:—On Sept. 3, Dr. F. Ristenpart, of the Observatory in Karlsruhe, with a 6-inch refractor, by comparing the Nova with the brightness of an accompanying star, estimates the Nova as of the 9·65 magnitude of the Bonn scale. Herr Cand. F. Kroeger observed the Nova on three different occasions—Sept. 3, 4, and 6. Comparing it with a neighbouring star of the 9·5m. (Star—Nova = $+\ 3^{s}{\cdot}5\ +\ 1'{\cdot}2$), the Nova was found to be about "a degree dimmer than the comparison star." On Sept. 4 the seeing was much better, and the Nova was about "two degrees brighter than the comparison star." On the third occasion, with excellent definition, the comparison star and the Nova were of equal brightness. These observations are all made between 12h. and 12h. 30m. Kiel mean time. Prof. E. E. Barnard has also made a very interesting observation with the 36-inch of the Lick Observatory, finding that the Nova appeared as a small, bright nebula, with a *star-like nucleus* of the 10th magnitude. The nebulosity, as he says, "was pretty, bright, and dense, and was 3″ in diameter. Surrounding this was a fainter glow, perhaps half a minute in diameter." If this observation can be verified, it will assuredly strengthen very considerably the hypothesis that the Nova was caused by collisions of meteorites, in the same way as the stars in the Pleiades nebula are the loci of intersecting streams, as clearly shown by Mr. Roberts' wonderful photographs.

ABERRATION PROBLEMS.[1]

EVERYBODY knows that to shoot a bird on the wing you must aim in front of it. Every one will readily admit that to hit a squatting rabbit from a moving train you must aim behind it.

These are examples of what may be called "aberration" from the sender's point of view, from the point of view of the source. And the aberration, or needful divergence between the point aimed at and the thing hit, has opposite sign in the two cases—the case when receiver is moving, and the case when source is moving. Hence, if both be moving, it is possible for the two aberrations to neutralize each other. So to hit a rabbit running alongside the train, you must aim straight at it.

If there were no air that is all simple enough. But every rifleman knows to his cost that though he fixes both himself and his target tightly to the ground, so as to destroy all aberration proper, yet a current of air is very competent to introduce a kind of spurious aberration of its own, which may be called windage; and that he must not aim at the target if he wants to hit it, but must aim a little in the eye of the wind.

So much from the shooter's point of view. Now attend to the point of view of the target.

Consider it made of soft enough material to be completely penetrated by the bullet, leaving a longish hole wherever struck. A person behind the target, whom we may call a marker, by applying his eye to the hole immediately after a hit, may be able to look through it at the shooter, and thereby to spot the successful man. I know that this is not precisely the function of an ordinary marker, but it is more complete than his ordinary function. All he does usually is to signal an impersonal hit; someone else has to record the identity of the shooter. I am rather assuming a volley of shots, and that the marker has to allocate the hits to their respective sources by means of the holes made in the target.

Well, will he do it correctly? assuming, of course, that he can do so if everything is stationary, and ignoring all curvature of path, whether vertical or horizontal curvature. If you think it over you will perceive that a wind will not prevent his doing it correctly; the line of hole will point to the shooter along the path of his bullet, though it will not point along his line of aim. Also, if the shots are fired from a moving ship, the line of hole in a stationary target will point to the position the gun occupied at the instant the shot was fired, though it may have moved since then. In neither of these cases (moving medium and moving source) will there be any aberration error.

But if the *target* is in motion, on an armoured train for instance, then the marker will be at fault. The hole will not point to the man who fired the shot, but to an individual ahead of him. The source will appear to be displaced in the direction of the observer's motion. This is common aberration. It is the simplest thing in the world. The easiest illustration of it is that when you run through a vertical shower, you tilt your umbrella forward; or, if you have not got one, the drops hit you in the face; more accurately, your face as you run forward hits the drops. So the shower appears to come from a cloud ahead of you, instead of from one overhead.

We have thus three motions to consider, that of the source, of the receiver, and of the medium; and of these only motion of receiver is able to cause an aberrational error in fixing the position of the source.

So far we have attended to the case of projectiles, with the object of leading up to light. But light does not consist of projectiles, it consists of waves; and with waves matters are a little different. Waves crawl through a medium at their own definite pace; they cannot be *flung* forwards or sideways by a moving source; they do not move by reason of an initial momentum which they are gradually expending, as shots do; their motion is more analogous to that of a bird or other self-propelling animal than it is to that of a shot. The motion of a wave in a moving medium may be likened to that of a rowing boat on a river. It crawls forward with the water, and it drifts with the water; its resultant motion is compounded of the two, but it has nothing to do with the motion of its source. A shot from a passing steamer retains the motion of the steamer as well as that given it by the powder. It is projected therefore in a slant direction. A boat lowered from the side of a passing steamer, and rowing off, retains none of the motion of its source; it is not projected, it is self-propelled. That is like the case of a wave.

The diagram illustrates the difference. Fig. 1 shows a moving cannon or machine-gun, moving with the arrow, and firing a succession of shots which share the motion of the cannon as well as their own, and so travel slant. The shot fired from position 1 has reached A, that fired from the position 2 has reached B, and that fired from position 3 has reached C by the time the fourth shot is fired at D. The line ABCD is a prolongation of the axis of the gun; it is the line of aim, but it is not the line of fire; all the shots are travelling aslant this line, as shown by the arrows. There are thus two directions to be distinguished. There is the row of successive shots, and there is the path of any one shot. These two directions enclose an angle. It may be called an aberration angle, because it is due to the motion of the source, but it need not give rise to any aberration. True direction may still be perceived from the point of view of the receiver. Attend to the target. The first shot is supposed to be entering at A, and if the target is stationary will leave it at Y. A marker looking along YA will see the position whence the shot was fired. This may be likened to a stationary observer looking at a moving star. He sees it where and as it was when the light started on its long journey. He does not see its present position, but there is no reason why he should. He does not see its physical state or anything as it is now. There is no aberration caused by motion of source.

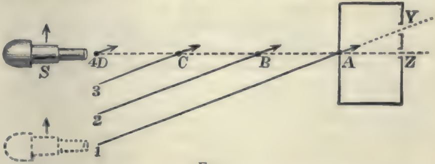

Fig. 1.

But now let the receiver be moving at same pace as the gun, as when two grappled ships are firing into each other. The motion of the target carries the point Y forward, and the shot A leaves it at Z, because Z is carried to where Y was. So in that case the marker looking along ZA will see the gun, not as it was when firing, but as it is at the present moment; and he will see likewise the row of shots making straight for him. This is like an observer looking at a terrestrial object. Motion of the earth does not disturb ordinary vision.

Fig. 2 shows as nearly the same sort of thing as possible for the case of emitted waves. The tube is a source emitting a succession of disturbances without momentum. ABCD may be thought of as horizontally flying birds, or as crests of waves; or they may even be thought of as bullets, if the gun stands still every time it fires, and only moves between whiles.

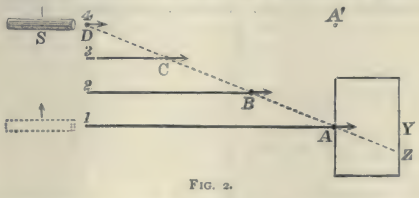

Fig. 2.

The line ABCD is now neither the line of fire nor the line of aim: it is simply the locus of disturbances emitted from the successive positions 1 2 3 4.

A stationary target will be penetrated in the direction AY, and this line will point out the correct position of the source when the received disturbance started. If the target moves, a disturbance entering at A may leave it at Z, or at any other point according to its rate of motion; the line ZA does not point to the source, and so there will be aberration when the target moves. Otherwise there would be none.

Now Fig. 2 also represents a parallel beam of light travelling from a moving source, and entering a telescope or the eye of an observer. The beam lies along ABCD, but this is not the direction of vision. The direction of vision to a stationary observer is determined not by the locus of successive waves, but by the path of each wave. A ray may be defined as the path of a labelled disturbance. The line of vision is YA1, and coincides with the line of aim; which in the projectile case (Fig. 1) it did not.

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[1] A lecture on "The Motion of the Ether near the Earth," by Dr. Oliver Lodge, at the Royal Institution, Friday evening, April 1, 1892.

The case of a revolving lighthouse, emitting long parallel beams of light and brandishing them rapidly round, is rather interesting. Fig. 3 may assist the thinking out of this case. Successive disturbances A,B,C,D, lie along a spiral curve, the spiral of Archimedes; and this is the shape of the beams as seen illuminating the dust particles, though the pitch of the spiral is too gigantic to be distinguished from a straight line. At first sight it might seem as if an eye looking along those curved beams would see the lighthouse slightly out of its true position; but it is not so. The true rays or actual paths of each disturbance are truly radial; they do not coincide with the apparent beam. An eye looking at the source will not look tangentially along the beam, but will look along AS, and will see the source in its true position. It would be otherwise for the case of projectiles from a revolving turret.

Thus, neither translation of star nor rotation of sun can affect direction. There is no aberration so long as the receiver is stationary.

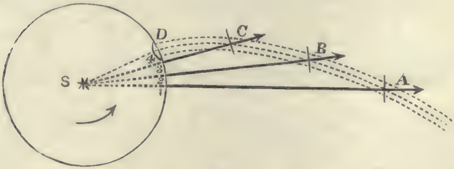

Fig. 3.

But what about a wind, or streaming of the medium past source and receiver, both stationary? Look at Fig. 1 again. Suppose a row of stationary cannon firing shots, which get blown by a cross wind along the slant 1AY (neglecting the curvature of path which would really exist): still the hole in the target fixes the gun's true position, the marker looking along YA sees the gun which fired the shot. There is no true deviation from the point of view of the receiver, although the shots are blown aside and the target is not hit by the particular gun aimed at it. With a moving cannon, combined with an opposing wind, Fig. 1 would become very like Fig. 2.

(N.B.—The actual case, even without complication of spinning, &c., but merely with the curved path caused by steady wind-pressure, is not so simple, and there would really be an aberration or apparent displacement of the source towards the wind's eye: an apparent exaggeration of the effect of wind as shown in the diagram.)

In Fig. 2 the result of a wind is much the same, though the details are rather different. The medium is supposed to be drifting down across the field opposite to the arrows. The source is stationary at S. The arrows show the direction of waves *in the medium*; the dotted slant line shows their resultant direction. A wave centre drifts from D to 1 in the same time as the disturbance reaches A, travelling down the slant line DA. The angle between dotted and full lines is the angle between ray and wave movement. Now, *if the motion of the medium inside the receiver is the same as it is outside*, the wave will pass straight on along the slant to Z, and the true direction of the source is fixed. But if the medium inside the target or telescope is stationary, the wave will cease to drift as soon as it gets inside, under cover as it were; it will proceed along the path it has been really pursuing *in the medium* all the time, and make its exit at Y. In this latter case, of different motion of the medium inside and outside the telescope, the apparent direction, such as YA, is not the true direction of the source. *The ray is in fact bent where it enters the differently-moving medium* (as shown in Fig. 4).

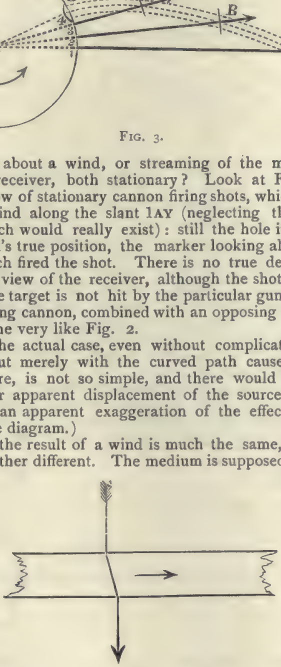

Fig. 4.

A slower moving stratum bends an oblique ray (slanting with the motion) in the same direction as a denser medium does. A quicker stratum bends it oppositely. If a medium is both denser and quicker moving, it is possible for the two bendings to be equal and opposite, and thus for a ray to go on straight. Parenthetically I may say that this is precisely what happens, on Fresnel's theory, down the axis of a water-filled telescope exposed to the general terrestrial ether drift.

In a moving medium waves do not advance in their normal direction, they advance slantways. The direction of their advance is properly called a ray. The ray does not coincide with the wave-normal in a moving medium.

All this is well shown in fig. 5.

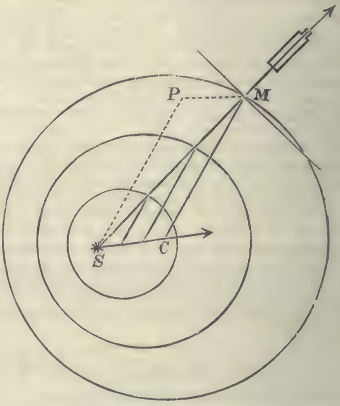

Fig. 5.

S is a stationary source emitting successive waves, which drift as spheres to the right. The wave which has reached M has its centre at C, and CM is its normal; but the disturbance, M, has really travelled along SM, which is therefore the ray. It has advanced as a wave from S to P, and has drifted from P to M. Disturbances subsequently emitted are found along the ray, precisely as in Fig. 2. A stationary telescope receiving the light will point straight at S. A mirror, M, intended to reflect the light straight back must be set normal to the ray, not tangential to the wave front.

The diagram also equally represents the case of a moving source in a stationary medium. The source, starting at C, has moved to S, emitting waves as it went, which waves as emitted spread out as simple spheres from the then position of source as centre. Wave-normal and ray now coincide: SM is not a ray, but only the locus of successive disturbances. A stationary telescope will look not at S, but along MC to the point where the source was when it emitted the wave M; a moving telescope, if moving at same rate as source, will look at S. Hence SM is sometimes called the *apparent* ray. The angle SMC is the aberration angle.

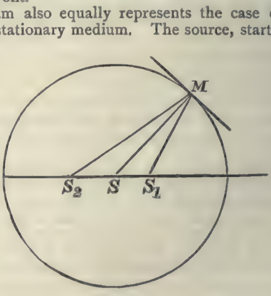

Fig. 6.

Fig. 6 shows normal reflection for the case of a moving source.

The mirror M reflects light received from S_1 to a point S_2, just in time to catch the source there; as it travels steadily to the left.

Parenthetically I may say that the time taken on the double journey, S_1MS_2, is not quite the same as the double journey SMS when all is stationary, and that this is the principle of Michelson's great experiment referred to below.

For the rest of the lecture I am going to call the medium which conveys light, "ether" simply. Every one knows that ether is the light-conveying medium, however little else they know about the properties of that tremendously important material.

We have arrived at this: that a uniform ether stream all through space causes no aberration, no error in fixing direction. It blows the waves along, but it does not disturb the line of vision.

Stellar aberration exists, but it depends on motion of observer, and on motion of observer only. Etherial motion has no effect upon it, and when the observer is stationary with respect to object, as he is when using a terrestrial telescope, there is no aberration at all.

Surveying operations are not rendered the least inaccurate by the existence of a universal etherial drift; and they therefore afford no means of detecting it.

But observe that everything depends on the etherial motion being uniform everywhere, inside as well as outside the telescope, and along the whole path of the ray. If stationary anywhere it must be stationary altogether. There must be no boundary between stationary and moving ether, no plane of slip, no quicker motion even in some regions than in others. For (referring back to the remarks preceding Fig. 4) if the ether in receiver is stagnant while outside it is moving, a wave which has advanced and drifted as far as the telescope will cease to drift as soon as it gets inside, but will advance simply along the wave-normal; and in general at the boundary of any such change of motion a ray will be bent, and an observer looking along the ray will see the source not in its true position, not even in the apparent position appropriate to his own motion, but lagging behind that position.

Such an aberration as this, a lag or negative aberration, has never yet been observed; but if there is any slip between layers of ether, if the earth carries any ether with it, or if the ether being in motion at all is not equally in motion everywhere throughout every transparent substance, then such a lag or negative aberration must occur: in precise proportion to the amount of the carriage of ether by moving bodies.

On the other hand, if the ether behaves as a perfectly frictionless inviscid fluid, or if for any other reason there is no rub between it and moving matter, so that the earth carries no ether with it at all, then all rays will be straight, aberration will have its simple and well-known value, and we shall be living in a virtual ether stream of 19 miles a second, by reason of the orbital motion of the earth.

It may be difficult to imagine that a great mass like the earth can rush at this tremendous pace through a medium without disturbing it. It is not possible for an ordinary sphere in an ordinary fluid. At the surface of such a sphere there is a viscous drag, and a spinning motion diffuses out thence through the fluid so that the energy of the moving body is gradually dissipated. The persistence of terrestrial and planetary motions shows that etherial viscosity, if existent, is small; or at least that the amount of energy thus got rid of is a very small fraction of the whole. But there is nothing to show that an appreciable layer of ether may not adhere to the earth and travel with it, even though the force acting on it be but small.

This, then, is the question before us:—

Does the earth drag some ether with it? or does it slip through the ether with perfect freedom? (never mind the earth's atmosphere: the part it plays is not important).

In other words, is the ether wholly or partially stagnant[1] near the earth, or is it streaming past us with the opposite of the full terrestrial velocity of nineteen miles a second? Surely if we are living in an ether stream of this rapidity we ought to be able to detect some evidence of its existence.

It is not so easy a thing to detect as you would imagine. We have seen that it produces no deviation or error in direction. Neither does it cause any change of colour or Doppler effect; that is, no shift of lines in spectrum. No steady wind can affect pitch, simply because it cannot blow waves to your ear more quickly than they are emitted. It hurries them along, but it lengthens them in the same proportion, and the result is that they arrive at the proper frequency. The precise effects of motion on pitch are summarized in the following table:—

Changes of Frequency due to Motion.

Source approaching shortens waves.
Receiver approaching alters relative velocity.
Medium flowing alters both wave-length and velocity in exactly compensatory manner.

What other phenomena may possibly result from motion? Here is a list:—

Phenomena resulting from Motion.

(1) Change or apparent change in direction; observed by telescope, and called aberration.

(2) Change or apparent change in frequency; observed by spectroscope, and called Doppler effect.

(3) Change or apparent change in time of journey; observed by lag of phase or shift of interference fringes.

(4) Change or apparent change in intensity; observed by energy received by thermopile.

Motion of either source or receiver can alter frequency, motion of receiver can alter apparent direction, motion of the medium can do neither; but surely it can hurry a wave so as to make it arrive out of phase with another wave arriving by a different path, and thus produce or modify interference effects.

Or again it may carry the waves down stream more plentifully than up stream, and thus act on a pair of thermopiles, arranged fore and aft at equal distances from a source, with unequal intensity.

And again, perhaps the laws of reflection and refraction in a moving medium are not the same as they are if it be at rest. Then, moreover, there is double refraction, colours of thin plates and thick plates, polarization angle, rotation of the plane of polarization; all sorts of optical phenomena.

It may be, perhaps, that in empty space the effect of an ether drift is difficult to detect, but will not the presence of dense matter make it easier? Consider No. 3 of the phenomena tabulated above.

I expect that everyone here understands interference, but I may just briefly say that two similar sets of waves "interfere" whenever and wherever the crests of one set coincide with and obliterate the troughs of the other set. Light advances in any given direction when crests in that direction are able to remain crests, and troughs to remain troughs. But if we contrive to split a beam of light into two halves, to send them round by different paths, and make them meet again, there is no guarantee that crest will meet crest and trough trough; it may be just the other way in some places, and wherever that opposition of phase occurs there there will be local obliteration or "interference." Two reunited half-beams of light may thus produce local stripes of darkness, and these stripes are called interference bands.

If I can I will produce actual interference of light on the screen, but the experiment is a difficult one to make visible at a distance, partly because the stripes or bands of darkness are usually very narrow. I have not seen it attempted before. [Very visible bands were formed on screen by three mirrors, one of them semi-transparent, arranged as in Fig. 7.]

Now a most interesting and important, and I think now well-known, experiment of Fizeau proves quite simply and definitely that if light be sent along a stream of water, travelling inside the water as a transparent medium, it will go quicker with the current than against it. You may say that is only natural; a wind helps sound along one way and retards it the opposite way. Yes, but then sound travels in air, and wind is a bodily transfer of air, hence, of course, it gives the sound a ride; whereas light does not really travel in water, but always in ether. It is by no means obvious whether a stream of water can help or hinder it. Experiment decides, however, and answers in the affirmative. It helps it along with just about half the speed of the water; not with the whole speed, which is curious and important, and really means that the moving water has no effect whatever on the ether of space, though it would take too long to make clear how this comes about. Suffice for present purposes the fact that the velocity of light inside moving water, and therefore presumably inside all transparent matter, is altered by motion of that matter.

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[1] The word "stationary" is ambiguous. I propose to use "stagnant," as meaning stationary with respect to the earth, *i.e.* as opposed to stationary in space.

Does not this fact afford an easy way of detecting a motion of the earth through the ether? Here on the table is water travelling along 19 miles a second. Send a beam of light through it one way and it will be hurried; its velocity, instead of being 140,000 miles a second, will be 140,009 miles. Send a beam of light the other way, and its velocity will be 139,991; just as much less. Bring these two beams together; surely some of their wave-lengths will interfere. M. Hoek, Astronomer at Utrecht, tried the experiment in this very form; here is a diagram of his apparatus (Fig. 8). Babinet had tried another form of the experiment previously. Hoek expected to see interference bands, from the two half-beams which had traversed the water, one in the direction of the earth's motion and the other against it. But no interference bands were seen. The experiment gave a negative result.

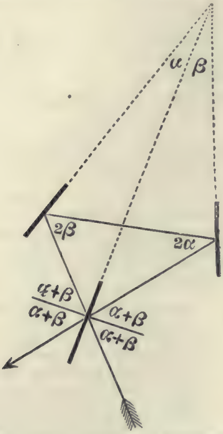

FIG. 7.—Plan of interference kaleidoscope.

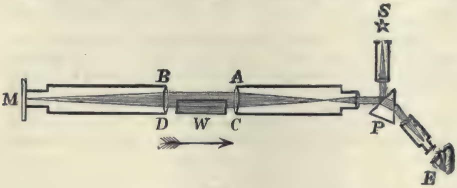

FIG. 8.

An experiment, however, in which nothing is seen is never a very satisfactory form of a negative experiment; it is, as Mascart calls it, "doubly negative," and we require some guarantee that the condition was right for seeing what might really have been in some sort there. Hence Mascart and Jamin's modification of the experiment is preferable (Fig. 9). The thing now looked for is a shift of already existing interference bands, when the above apparatus is turned so as to have different aspects with respect to the earth's motion; but no shift was seen.

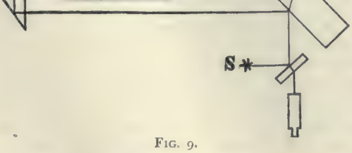

FIG. 9.

Interference methods all fail to display any trace of relative motion between earth and ether.

Try other phenomena then. Try refraction. The index of refraction of glass is known to depend on the ratio of the speed of light outside, to the speed inside, the glass. If then the ether be streaming through glass, the velocity of light will be different inside it according as it travels with the stream or against it, and so the index of refraction will be different. Arago was the first to try this experiment, by placing an achromatic prism in front of a telescope on a mural circle, and observing the deviation it produced on stars.

Observe that it was an *achromatic* prism, treating all wave-lengths alike; he looked at the *deviated* image of a star, not at its *dispersed* image or spectrum, else he might have detected the change-of-frequency-effect due to motion of source or receiver first actually seen by Dr. Huggins. I do not think he would have seen it, because I do not suppose his arrangements were delicate enough for that very small effect; but there is no error in the conception of his experiment, as Prof. Mascart has inadvertently suggested there was.

Then Maxwell repeated the attempt in a much more powerful manner, a method which could have detected a very minute effect indeed, and Mascart has also repeated it in a simple form. All are absolutely negative.

Well, what about aberration? If one looks through a moving stratum, say a spinning glass disk, there ought to be a shift caused by the motion (see Fig. 4). The experiment has not been tried, but I entertain no doubt about its result, though a high speed and considerable thickness of glass or other medium is necessary to produce even a microscopic apparent displacement of objects seen through it.

But the speed of the earth is available, and the whole length of a telescope tube may be filled with water; surely that is enough to displace rays of light appreciably.

Sir Geo. Airy tried it at Greenwich on a star, with an appropriate zenith-sector full of water. Stars were seen through the water-telescope precisely as through an air telescope. A negative result again.

Stellar observations, however, are unnecessarily difficult. Fresnel had said that a terrestrial source of light would do just as well. He had also (being a man of exceeding genius) predicted that nothing would happen. Hoek has now tried it in a perfect manner and nothing did happen.

Since then Prof. Mascart with great pertinacity has attacked the phenomena of thick plates, Newton's rings, double refraction, and the rotatory phenomenon of quartz; but he has found absolutely nothing attributable to a stream of ether past the earth.

The only positive result ever supposed to be attained was in a very difficult polarization observation by Fizeau in 1859. As this has not yet been repeated, it is safest at present to ignore it, though by no means to forget that it wants repeating.

Fizeau also suggested, but did not attempt, what seems an easier experiment, with fore and aft thermopiles and a source between them, to observe the drift of a medium by its convection of energy; but arguments based on the law of exchanges[1] tend to show, and do show as I think, that a probable alteration of radiating power due to motion through a medium would just compensate the effect otherwise to be expected.

We may summarize most of these statements as follows:—

Summary.

Source alone moving produces	A real and apparent change of wave-length. A real but not apparent error in direction. No lag of phase or change of intensity, except that appropriate to altered wave-length.
Medium alone moving, or source and receiver moving together, produces	No change of frequency. No error in direction. A real lag of phase, but undetectable without control over the medium. A change of intensity corresponding to different distance, but compensated by change of radiating power.

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[1] Lord Rayleigh (NATURE, March 25, 1892).

Receiver alone moving produces	An apparent change of wave-length. An apparent error in direction. No change of phase or of intensity, except that appropriate to different virtual velocity of light.

I may say, then, that not a single optical phenomenon is able to show the existence of an ether stream near the earth. All optics goes on precisely as if the ether were stagnant with respect to the earth.

Well then perhaps it *is* stagnant. The experiments I have quoted do not prove that it is so. They are equally consistent with its perfect freedom and with its absolute stagnation; though they are not consistent with any intermediate position. Certainly, if the ether were stagnant, nothing could be simpler than their explanation.

The only phenomena then difficult to explain would be those depending on light coming from distant regions through all the layers of more or less dragged ether. The theory of astronomical aberration would be seriously complicated; in its present form it would be upset. But it is never wise to control facts by a theory: it is better to invent some experiment that will give a different result in stagnant and in free ether. None of those experiments so far described are really discriminative. They are, as I say, consistent with either hypothesis, though not very obviously so.

Mr. Michelson, however, of the United States, has invented a plan that will discriminate; and, what is much more remarkable, he has carried it out.

That it is an exceptionally difficult experiment you will realize when I say that the experiment will fail altogether unless one part in 400 millions can be clearly detected.

Mr. Michelson reckons that by his latest arrangement he could see 1 in 4000 millions if it existed (which is equivalent to detecting an error of $\frac{1}{1000}$ of an inch in a length of forty miles); but he saw nothing. Everything behaved precisely as if the ether was stagnant; as if the earth carried with it all the ether in its immediate neighbourhood. And that is his conclusion. If he can repeat it and get a different result on the top of a mountain, that conclusion may be considered established. At present it must be regarded as tentative.

I have not time to go into the details of his experiment (it is described in *Phil. Mag.* 1887), but I may say that it depends on no doubtful properties of transparent substances, but on the straightforward fundamental principle underlying all such simple facts as that—It takes longer to row a certain distance and back up and down stream than it does to row the same distance in still water; or that it takes longer to run up and down a hill than to run the same distance laid out flat; or that it costs more to buy a certain number of oranges at three a penny and an equal number at two a penny than it does to buy the whole lot at five for twopence.

Hence, although there may be some way of getting round Mr. Michelson's experiment, there is no obvious way; and I conjecture that if the true conclusion be not that the ether near the earth is stagnant, the experiment will lead to some other important and unknown fact.

The balance of evidence at this stage seems to incline in the sense that the earth carries the neighbouring ether with it.

But now put the question another way. *Can* matter carry neighbouring ether with it when it moves? Abandon the earth altogether; its motion is very quick, but too uncontrollable, and it always gives negative results. Take a lump of matter that you can deal with, and see if it pulls any ether along.

That is the experiment I set myself to perform, and which, in the course of the last year, I have performed.

I take a steel disk, or rather a couple of steel disks clamped together with a space between. I mount it on a vertical axis and spin it like a teetotum as fast as it will stand without flying to pieces. Then I take a parallel beam of light, split it into two by a semi-transparent mirror (Michelson's method), a piece of glass silvered so thinly that it lets half the light through and reflects the other half; and I send the two halves of this split beam round and round in opposite directions in the space between the disks. They may thus travel a distance of 20 or 30 or 40 feet. Ultimately they are allowed to meet and enter a telescope. If they have gone quite identical distances they need not interfere, but usually the distances will differ by a hundred-thousandth of an inch or so, which is quite enough to bring about interference.

The mirrors which reflect the light round and round between the disks are shown in Fig. 10. If they form an accurate square the last two images will coincide, but if the mirrors are the least inclined to one another at any unaliquot part of 360° the last image splits into two, as in the kaleidoscope is well known, and the interference bands may be regarded as resulting from those two sources. The central white band bisects normally the distance between them, and their amount of separation determines the width of the bands. There are many interesting optical details here, but I shall not go into them.

The thing to observe is whether the motion of the disks is able to replace a bright band by a dark one, or *vice versâ*. If it does, it means that one of the half beams, viz. that which is travelling in the same direction as the disks, is helped on a trifle, equivalent to a shortening of journey by some quarter millionth of an inch or so in the whole length of 30 feet; while the other half beam, viz., that travelling against the motion of the disks, is retarded, or its path virtually lengthened, by the same amount.

If this acceleration and retardation actually occurs, waves which did not interfere on meeting before the disks moved, will interfere now, for one will arrive at the common goal half a length behind the other.

Now a gradual change of bright space to dark, and *vice versâ*, shows itself, to an observer looking at the bands, as a gradual change of position of the bright stripes, or a shift of the bands. A shift of the bands, and especially of the middle white band, which is much more stable than the others, is what we look for.

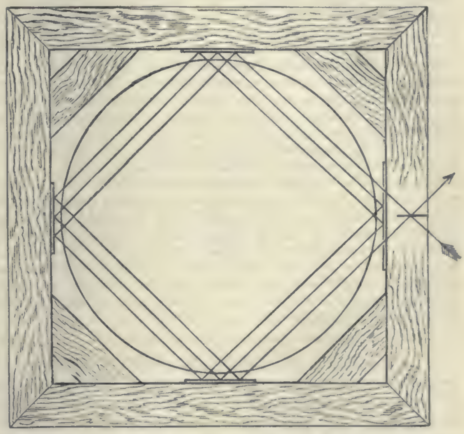

FIG. 10.—Plan of steel disks one yard in diameter, and optical frame; showing the light going round and round, three times each way, between the disks.

At first I saw plenty of shift. In the first experiment the bands sailed across the field as the disks got up speed until the crosswire had traversed a band and a half. The conditions were such that had the ether whirled at the full speed of the disks I should have seen a shift of three bands. It looked very much as if the light was helped along at half the speed of the moving matter, just as it is inside water.

On stopping the disks the bands returned to their old position. On starting them again in the opposite direction, the bands ought to have shifted the other way too; but they did not; they went the same way as before.

The shift was therefore wholly spurious; it was caused by the centrifugal force of the blast of air thrown off from the moving disks. The mirrors and frame had to be protected from this. Many other small changes had to be made, and gradually the spurious shifts have been reduced and reduced, largely by the skill and patience of my assistant, Mr. Davies, until now there is barely a trace of them.

But the experiment is not an easy one. Not only does the blast exert pressure, but at high speeds the churning of the air makes it quite hot. Moreover, the tremor of the whirling machine, in which some four or five horse-power is sometimes being expended, is but too liable to communicate itself to the optical part of the apparatus. Of course elaborate precautions are taken against this. Although the two parts, the mechanical and the optical, are so close together, their supports are entirely independent. But they have to rest on the same earth, and hence communicated tremors are not absent. They are the cause of all the slight residual trouble.

The method of observation now consists in setting a wire of the micrometer accurately in the centre of the middle band, while another wire is usually set on the first band to the left. Then the micrometer heads are read, and the setting repeated once or twice to see how closely and dependably they can be set in the same position. Then we begin to spin the disks, and when they are going at some high speed, measured by a siren note and in other ways, the micrometer wires are reset and read —reset several times and read each time. Then the disks are stopped and more readings are taken. Then their motion is reversed, the wires set and read again; and finally the motion is once more stopped and another set of readings taken. By this means the absolute shift of middle band and its relative interpretation in terms of wave-length are simultaneously obtained; for the distance from the one wire to the other, which is often two revolutions of a micrometer head, represents a whole wave-length shift.

In the best experiments I do still often see something like a fiftieth of a band shift, but it is caused by residual spurious causes, for it repeats itself with sufficient accuracy in the same direction when the disks are spun the other way round.

Of real reversible shift, due to motion of the ether, I see nothing. I do not believe the ether moves. It does not move at a five-hundredth part of the speed of the steel disks. I hope to go further, but my conclusion so far is that such things as circular-saws, flywheels, railway trains, and all ordinary masses of matter do not appreciably carry the ether with them. Their motion does not seem to disturb it in the least.

The presumption is that the same is true for the earth; but the earth is a big body, it is conceivable that so great a mass may be able to act when a small mass would fail. I would not like to be too sure about the earth. What I do feel already pretty sure of is that if moving matter disturbs ether in its neighbourhood at all, it does so by some minute action, comparable in amount perhaps to gravitation, and possibly by means of the same property as that to which gravitation is due—not by anything that can fairly be likened to ethereal viscosity.

NATIVE NEW ZEALAND BIRDS.

FROM a scientific point of view it is of so much importance that native New Zealand birds should be protected that many naturalists will read with interest the following memorandum, which was drawn up by Lord Onslow, the late Governor of New Zealand, and presented to both Houses of the General Assembly by command of his Excellency:—

It is admitted by naturalists that New Zealand possesses in some respects the most interesting avifauna in the world. It is a melancholy fact that, under the changed condition of existence this remarkable avifauna is passing away. Some of the species have already disappeared, whilst others are verging on extinction. Take, for example, the wingless birds of New Zealand. These diminutive representatives of the gigantic brevipennate birds which formerly inhabited New Zealand are objects of the highest interest to the natural historian. The kiwis, like their colossal prototypes the moas, once existed in very considerable numbers in almost every part of the country. At the time of the first colonization of New Zealand, fifty years ago, they were still abundant in all suitable localities. At the present day their last refuges may be indicated on the map without any difficulty. The North Island species (*Apteryx bulleri*) is still comparatively plentiful in the wooded heights of Pirongia and in the bosky groves of the Upper Wanganui. From all other localities where formerly numerous it has practically disappeared. The South Island kiwi (*Apteryx australis*) is now met with in only widely-scattered localities on the west coast. The small spotted or grey kiwi (*Apteryx oweni*), of which perhaps thousands could have been obtained a few years back, has succumbed to the ravages of the stoat and weasel, the persecution by wild dogs, and the necessities of roving diggers, and it is only now to be found in any number along the lower wooded ranges of the Southern Alps. *Apteryx haasti* is one of our rarest species, and *Apteryx maxima* is strictly confined to the wooded parts of Stewart Island.

The kakapo, or ground-parrot (*Stringops habroptilus*), which was formerly so abundant in the wooded country along the whole of the West Coast Sounds and on the western slope of the Southern Alps, is becoming a scarce bird. According to Mr. Richardson, who recently read an exhaustive paper on the subject before the Otago Institute, both the kiwi and the kakapo are now confined to very restricted districts, within which, under the combined attacks of introduced wild dogs and cats, stoats, weasels, and ferrets, they are fast diminishing.

The blue-wattled crow and South Island thrush, which were every-day camp-visitors when Sir James Hector explored the West Coast in 1863, are now very rarely seen; whilst in the North Island the native thrush and some of the smaller birds have disappeared altogether.

Prominent writers on zoological science, such as Prof. Newton, of Cambridge, Prof. Flower, at the head of the British Museum, and Dr. Sclater, the accomplished secretary of the Zoological Society of London, have over and over again urged the importance of some steps being taken for the conservation of New Zealand birds; and they have pointed out that it will be a lasting reproach to the present generation of colonists if no attempt is made to save some—if only a remnant—of these expiring forms for the student of the future. Thus, Prof. Newton, in his address to the Biological Section of the British Association, at Manchester, in 1887, saith: "I would ask you to bear in mind that these indigenous species of New Zealand are, with scarcely an exception, peculiar to the country, and, from every scientific point of view, of the most instructive character. They supply a link with the past that, once lost, can never be recovered. It is therefore incumbent upon us to know all we can about them before they vanish. . . . The forms we are allowing to be killed off, being almost without exception ancient forms, are just those that will teach us more of the way in which life has spread over the globe than any other recent forms; and for the sake of posterity, as well as to escape its reproach, we ought to learn all we can about them before they go hence and are no more seen."

The chief cause of the destruction of native birds is no doubt the introduction of foreign animals, against which the indigenous species are unable to contend successfully in the struggle for existence, especially under the changed conditions of life brought about by colonization. Probably the chief factor in this work of destruction is the Norway rat, whose introduction was of course unintentional, but an inevitable incident of settlement. The insectivorous and other birds introduced (whether wisely or not it is not necessary now to discuss) by our various acclimatization societies have, as it were, driven out and replaced many of the native species. These latter have succumbed to some general law of nature under which races of animals and plants yield to foreign invasion and rapidly disappear, the aboriginal races of man being no exception to this general rule. Where the causes themselves are recondite, it is, of course, difficult to find the means of counteracting them; but it is an observed law of nature that expiring races survive and linger longest in insular areas. That has been the experience of zoologists all over the world, the islands of Mauritius and Rodriguez presenting a striking instance in point. Here in New Zealand we have many similar evidences. The remarkable tuatara lizard (*Sphenodon punctatum*), supposed to be a survival from a very ancient fauna, and constituting, *per se*, a distinct order of reptilia, which years ago became extinct on the mainland (chiefly through the ravages of introduced wild pigs), still exists in very considerable numbers on the small islands lying off our coasts. The makomako, or bell-bird (*Anthornis melanura*), at one time the very commonest of our birds, although still plentiful in the South Island, has absolutely disappeared from every part of the North Island, but it still exists on the wooded islands of the Hauraki Gulf and Bay of Plenty, and on the island of Kapiti, in Cook Strait. The same remarks apply with almost equal force to the wood-robin (*Miro albifrons*) and the white-head (*Clitonyx albicapilla*), two species which have never inhabited the South Island at all. The stitch-bird (*Pogonornis cincta*), which forms a sort of connecting link with the avifauna of Australia, was thirty years ago very plentiful in the woods surrounding Wellington, but it had long before disappeared from the northern parts of the island. It is now extinct all over the mainland, but it exists in comparative plenty on the little Barrier Island—presumably the only locality in the world where this species is now to be found.

All these facts and considerations point to the conclusion that if an attempt is to be made to preserve these and other indigenous species, it must be by setting apart suitable islands for the purpose, and placing them under very strict protective regulations.

Assuming it to be granted that it is the duty of the Government to take the necessary measures, the next question is, what islands are the most suitable for the purpose?

After making careful inquiries on the subject, and reading much that has been written by the Chief Surveyor and other local authorities, I have come to the conclusion that the two best and most readily available islands are the Little Barrier at the north, and Resolution Island at the south.

1. *The Little Barrier.*—This island is still in the hands of the Maoris; but the Government is in negotiation for its purchase, and, as I understand there is only a small amount at issue between the parties, I would strongly urge its immediate acquisition for the purposes indicated. Not only is the Little Barrier known to be the habitat of the stitch-bird, the whitehead, the bell-bird, and the native robin (all of which have practically disappeared from the mainland), but it has a wooded surface admirably adapted to the habits of such birds; it is easily accessible from Auckland; it would be difficult for any person to land and shoot birds there without at once attracting the attention of the many ships which are constantly passing in and out of the Hauraki Gulf.

2. *Resolution Island.*—This has now been proclaimed a reserve for native fauna and flora.

(1) Resolution Island is just at a convenient distance from the mainland. It is of considerable extent, with good harbours having deep water and safe anchorage.

(2) Several of the species that it is most desirable to preserve (such as kakapo and kiwi) are known to exist there already in considerable numbers.

(3) It is believed to be the final refuge of the great flightless rail (*Notornis mantelli*), only three specimens of which have ever been obtained in New Zealand, two of these being now in the National Museum, and the other in the Royal Museum at Dresden. One of those in the British Museum (obtained by Mr. Walter Mantell in 1849) was caught by a party of sealers at Duck Cove, on Resolution Island, and the other was captured by Maoris on Secretary Island, opposite to Dea's Cove, Thompson Sound. The third was taken as recently as 1881 by a party of rabbit-hunters in the vicinity of Lake Te Anau. There is every reason to believe that this rare and interesting species still survives on the island which has now been set apart as a permanent Government reserve.

Looking to the interests involved—the great loss to the scientific world implied in the extermination of natural forms that do not exist elsewhere, and the importance, therefore, of saving them—it cannot be denied that a heavy responsibility rests on those who, while there is yet time and opportunity, may neglect to take the necessary steps for their preservation.

All that is wanted to rouse public interest in such a matter is actual knowledge of the facts. There is a strong sentiment always in the public mind against the final extirpation of any living species. As a proof of this one has only to read of the strong public feeling that exists in San Francisco in regard to the protection of the "sea-lions" frequenting the famous Seal Rocks lying off the shore, and of the universal regret with which the Americans regard the almost complete extirpation of the herds of bison, of which at the present day only a small remnant survives under Government protection within certain "reservations." It finds further expression in the lament of all true sportsmen and naturalists on account of the disappearance, through wanton slaughter, of the large game of South Africa. Look, for example, at the quagga, which is now on the verge of extinction. Forty years ago this fine animal might be counted by thousands on every valley and plain of the Cape Colony. At the present day, besides three mounted specimens in European museums, there are two living examples in the Zoological Gardens. Take these away, and the species is blotted out completely.

In urging Ministers to take this subject under their serious consideration I may remind them that on December 16, 1886, the Secretary of the Auckland Institute wrote advising the purchase of the Little Barrier Island as a Government preserve, and that the Premier, Sir Robert Stout, approved of this being done. The purchase was, I believe, strongly advocated by Prof. Thomas and by Mr. A. Reischek, the Austrian collector, both of whom had visited the island and inspected every part of it. At a recent meeting of the Otago Institute a resolution was passed authorizing the Council of that body to move the Government to proclaim Resoluttion Island for this purpose.

Resolution Island having now been so proclaimed, I would suggest that steps should be immediately taken for ascertaining to what extent Resolution Island is already stocked with kiwi and kakapo; that a sufficient supply of these and other birds be at once obtained by purchase or otherwise from the mainland before it is too late, and turned loose both on this island and on the Little Barrier; and that Captain Fairchild (who takes a keen interest in this project) should be instructed to call at these islands from time to time during the periodical cruises of the *Hinemoa*, to ascertain if the birds are thriving, and to report results, with such practical suggestions and recommendations as he may be able to make for the furtherance of this plan of conservation.

I would also, at the same time, suggest that Ministers should take into consideration the propriety of including some other native birds in the list of protected species. As I have already mentioned, the bell-bird, formerly so plentiful, has entirely disappeared from the North Island. But it is still very plentiful all over the South Island, and is a common denizen of the gardens and shrubberies in all the principal towns. This is the bird that so enchanted Captain Cook by its song when his ship lay at anchor in Queen Charlotte Sound more than a hundred years ago, and, having become historical, it would be a grievous pity for the bird to die out altogether. The general testimony goes to show that the protection extended to the tuis had the desired effect, this species being now more numerous everywhere than it was fifteen years ago. Would it not be well to extend the same protection to its small congener the makomako, whose haunts and habits are almost precisely similar?

Then, again, there is a bird famous in Maori history and poetry—remarkable for its singular beauty, and interesting to naturalists on account of its aberrant generic characters—a species confined to a very limited portion of the North Island, from which, owing to the eagerness of natural-history collectors and the inevitable progress of settlement in its native woods, it is fast disappearing.

I refer, of course, to the huia (*Heteralocha acutirostris*), a bird which is naturally confined within such narrow geographical boundaries that I may describe its range as being limited to the Ruahine, Tararua, and Rimutaka Mountain-ranges, with their divergent spurs and the intervening wooded valleys. The white-tipped tail-feathers of this beautiful bird have been from time immemorial the chief adornment of Maori chiefs as head-plumes; and an incident connected therewith, in ancient times, led to the adoption of the name by the great ancestors of the Ngatihuia Tribe.

As Ministers are aware, when selecting a Maori name for my infant son, to commemorate his New Zealand birth, I was induced, for several considerations, to give this name the preference over all others submitted to me; and I should therefore accept it as a compliment to my family if Ministers would exercise the power they possess and throw over this bird the shield of Government protection.[1]

I ask this the more readily on the ground that I have been moved to do so by the chiefs of the Ngatihuia Tribe. At the public function at Otaki, on the 12th September last, when I had the pleasure of presenting my son to the assembled tribes, a number of very complimentary speeches were made by the leading chiefs, and one of them, in referring to the name, said, "There, yonder, is the snow-clad Ruahine range, the home of our favourite bird. We ask you, O Governor! to restrain the pakehas from shooting it, that when your boy grows up he may see the beautiful bird which bears his name."

The huia loves the deep shade of the forest, and as its home is invaded by the settler's axe it would, if protected from reckless destruction, simply retire higher up the wooded ranges, till it finally took refuge in the permanent forest reserve, which embraces all the wooded mountain-tops within its natural domain. Under vigilant protection, therefore, the huia would have every chance of being preserved and perpetuated.

Christchurch, Christmas Day, 1891. ONSLOW.

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[1] This has been done: *vide New Zealand Gazette* of February 25. 1892. page 402.

A CENTURY OF SCIENTIFIC WORK.

EVERYONE interested in science is aware that the "Société de Physique et d'Histoire Naturelle de Genève" has won for itself an honoured place among the learned Societies of the Continent. Work of the highest interest and importance has been done by many of its ordinary members, and the list of its honorary members includes a very large number of the investigators who, in different parts of Europe, have contributed most effectually to scientific progress. Some time ago this excellent Society celebrated the hundredth anniversary of its foundation, and an interesting supplementary volume has now been issued in memory of the occasion. To this volume Dr. A. H. Wartmann contributes a sketch of the Society's history, and it may be worth while to note some of the facts he has recorded.

Nominally, the Society was founded in 1790. That is, several men of science in Geneva agreed in that year to unite in forming it. As a matter of fact, however, the first official meeting was not held until 1791. The Society was called at first the "Société des Naturalistes Genevois," and there were eight members, who met in each other's houses on the second and fourth Thursday of every month. The President was M. Gosse. A secretary and a treasurer were appointed; the annual subscription was fixed at two crowns; and an effort was made to obtain copies of the scientific journals of the time. It was felt that there ought to be more than eight members, so the honour of membership was offered to several men of science, by the majority of whom it was accepted. Foreign men of science who happened to be passing through Geneva were invited by the President to attend the meetings, and some of them were made honorary members. In the course of the first year M. Jurine made a present of his herbarium to the Society; this was the origin of its collections. One of the first objects of the Society was the creation of a botanic garden, and a site was chosen which has ever since been retained. M. Micheli presented a hot-house; exotic plants and seeds were obtained; and courses of instruction in botany were given under the Society's auspices by MM. Micheli and de Saussure.

The most eminent representative of science in Geneva at this time was Charles Bonnet. He was asked to become the patron or Honorary President of the new Society. He would have preferred the position of *confrère*, but ended by complying with the request. He died in 1793, bequeathing to the Society 300 crowns, which provided for the maintenance of a gardener and other necessary expenses in the botanic garden.

The activity of the young Society was shown in a series of labours in the physical and natural sciences—labours of which an account has been given by Vaucher, one of the founders. The question of a diploma of reception was raised, and, after much consideration, a seal was prepared. This was abandoned in 1819 in favour of a seal engraved by Bovy.

In 1792 the Society changed its name to "Société Genevoise d'Histoire Naturelle." Shortly afterwards the name by which the Society is still known was adopted.

Under an impulse due to M. d'Albert Henri Gosse, two other scientific Societies were founded in Geneva. One, created in 1803, went back to the name of "Société des Naturalistes." In 1829 it was merged in the "Société de Physique et d'Histoire Naturelle," in whose archives its papers are preserved. Many of these, according to M. Wartmann, are of some importance. The other Society was the "Société Helvétique des Sciences Naturelles," founded in 1815. Of this Society, which has continued to flourish, the "Société de Physique" may be regarded as the Genevese section. When it met at Geneva, in 1866, the two Societies united in the ceremony at the unveiling of a monument to M. Gosse.

When the number of members increased, a fixed place of meeting became necessary. They met for some years at the Société des Arts, then (from 1826) at the Academic Museum, and afterwards (from 1872) in the hall of the Société des Arts. The times of meeting were changed from the second and fourth to the first and third Thursday of every month; and in 1834 it was decided that a meeting should be held only on the first Thursday of the month.

The President holds office for a year. A Vice-President is also appointed. From 1858 to 1879 the President entered upon his duties in July, and in the following June he was succeeded by the Vice-President. Now the President and Vice-President assume office at the beginning of the year.

The Society consists of active members, emeritus members, and honorary members. The former—limited in 1822 to forty, in 1863 to fifty, in 1878 to sixty—reside in the canton. The emeritus members are members who have ceased to take an active part in the Society's work. The honorary members—limited in 1859 to seventy, in 1878 to sixty—are chosen from among men of science in Switzerland or any other part of the world. There are also "associés libres," who cannot be appointed before the age of twenty-five.

Although women do not habitually attend the meetings, there is nothing to prevent them from being connected with the Society. Mrs. Somerville was an honorary member from 1834 to 1873.

Very many communications submitted to the Society have marked important stages in the development of science. At first some of the communications used to appear in foreign periodicals or in the *Bibliothèque Britannique*, which afterwards became the *Bibliothèque Universelle*. In 1820 it was decided that a collection of Memoirs should be issued, and that the task of selecting the papers should be intrusted to a Committee of Publication. This Committee still exists, its secretary being known as the corresponding secretary. The first volume, consisting of two numbers, appeared in 1821 and 1822, and in 1890 appeared the second part of the thirtieth volume. The publication of the Memoirs, many of which are accompanied with plates, is very costly, but sometimes the writers bear the whole or a part of the expense. A *Bulletin*, presenting a *résumé* of the proceedings, has been issued regularly since 1884, and an account has also been given since 1883 in the *Archives des Sciences Physiques et Naturelles.*

The funds of the Society are derived from subscriptions, gifts, and bequests. At first the amount of the annual subscription varied in accordance with the Society's needs, but in 1860 it was fixed at twenty francs. From 1829 to 1854 the Society was officially recognized by the State as the "Société Cantonale de Physique et d'Histoire Naturelle," and received an annual subsidy; but during the last thirty-eight years there has been no relation of this kind between the Society and the Government. A sum of 1200 francs is paid annually by the Administrative Council for the books and memoirs with which the Society enriches the public library of Geneva.

The various collections possessed by the Society have been given partly to the Museum of Natural History, partly to the Botanic "Conservatoire." A prize of 500 francs is offered every five years for the best essay on a genus or family of plants. The sum of 2400 francs which enables this prize to be offered was left to the Society for the purpose in 1841 by A. P. de Candolle. Since 1886 the Society has reserved for itself, at a cost of 600 francs per annum, a place at the Zoological Laboratory of Villefranche, and the person who is to be allowed to take advantage of it is chosen in accordance with a fixed set of rules.

The Society now includes fifty-four ordinary members, four emeritus members, fifty honorary members, and thirty-one *associés libres*. Among the honorary members are many of the most eminent men of science in Europe and America.

THE TRANSMISSION OF ACQUIRED CHARACTERS THROUGH HEREDITY.

THE bearing of insects upon this subject is very clearly brought out by Prof. C. V. Riley in a recently published paper on "Some Interrelations of Plants and Insects" read before the Biological Society of Washington. After dealing with the facts connected with the insects associated with the interesting plants of the genus Yucca and the pollination of their flowers by the Yucca Moth, and touching briefly upon certain aspects of fig-caprification, he makes the following remarks:—

"Now, when it comes to the bearing which the history of these little moths has upon some of the larger questions that are now concerning naturalists (for instance, the transmission of acquired characters, or the origin, development, and nature of the intelligence displayed by the lower animals), broad fields of interesting opinion and conclusion open up before us—fields that cannot possibly be explored without trenching too much upon your time. I will close, therefore, with a few summary expressions of individual opinion, without attempting to elaborate the reasons in detail, and with the object of eliciting further discussion, which is one of the objects of the paper. My first conviction is that insect life and development give no countenance to the Weissman school, which denies the transmission of functionally acquired characters, but that, on the contrary, they furnish the strongest refutation of the views urged by Weissman and his followers. The little moths of which I have been speaking, and indeed the great majority of insects—all, in fact, except the truly social species—perform their humble parts in the economy of nature without teaching or example, for they are, for the most part, born orphans, and without relatives having experience to communicate. The progeny of each year begins its independent cycle anew. Yet every individual performs more or less perfectly its allotted part, as did its ancestors for generation after generation. The correct view of the matter, and one which completely refutes the more common idea of the fixity of instinct, is that a certain number of individuals are, in point of fact, constantly departing from the lines of action and variation most useful to the species, and that these are the individuals which fail to perpetuate their kind and become eliminated through the general law of natural selection.

"Whether these actions be purely unconscious and automatic or more or less intelligent and conscious, does not alter the fact that they are necessarily inherited. The habits and qualities that have been acquired by the individuals of each generation could have become fixed in no other way than through heredity. Many of these acts, which older naturalists explained by that evasive word "instinctive," may be the mere unconscious outcome of organization, comparable to vegetative growth; but insects exhibit all degrees of intelligence in their habits and actions, and they perform acts which, however voluntary and, as I believe, conscious in many cases, as in that of our Yucca Moth, could not be performed were the tendency not inherited. Every larvæ which spins or constructs a hibernaculum, or a cocoon in which to undergo its transformations, exemplifies the potent power of heredity in transmitting acquired peculiarities. A hundred species of parasitic larvæ, *e.g.*, of the family Braconidæ, which in themselves are almost or quite indistinguishable from one another structurally, will nevertheless construct a hundred distinctive cocoons—differing in form, in texture, in colour and in marking—each characteristic of its own species, and in many instances showing remarkable architectural peculiarities. These are purely mechanical structures, and can have little or nothing to do with the mere organization or form or structure of the larva, but they illustrate in the most convincing manner the fact that the tendency to construct, and the power to construct, the cocoon after some definite plan, must be fixed by heredity, since there is no other way of accounting for it. This fact alone, which no one seems to have thought of in the discussion, should be sufficient to confound the advocates of the non-transmissibility of acquired characteristics.

"Thus, to my view, modification has gone on in the past, as it is going on at the present time, primarily through heredity in the insect world. I recognize the physical influence of environment; I recognize the effect of the interrelation of organisms; I recognize, even to a degree that few others do, the psychic influence, especially in higher organisms—the power of mind, will, effort, or the action of the individual as contradistinguished from the action of the environment; I recognize the influence of natural selection, properly limited; but above all, as making effective and as fixing and accumulating the various modifications due to these or whatever other influences, I recognize the power of heredity, without which only the first of the influences mentioned can be permanently operative."

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The CAMBRIDGE UNIVERSITY PRESS promises:—"The Collected Mathematical Papers of Prof. Arthur Cayley, Sc.D., F.R.S.," vol. v.; "A History of the Theory of Elasticity and of the Strength of Materials," by the late I. Todhunter, Sc.D., F.R.S., edited and completed by Prof. Karl Pearson, vol. ii., Saint Venant to Lord Kelvin (Sir William Thomson); "A Treatise on Analytical Statics," by E. J. Routh, Sc.D., F.R.S., vol. ii.; "A Treatise on the Theory of Functions of a Complex Variable," by A. R. Forsyth, Sc.D., F.R.S.; "The Jurassic Rocks of Cambridge," being the Sedgwick prize essay for the year 1886, by the late T. Roberts, M.A.; "Fossil Plants as Tests of Climate," being the Sedgwick prize essay for 1892, by A. C. Seward, M.A.; "An Elementary Treatise on Plane Trigonometry," by E. W. Hobson, Sc.D., and C. M. Jessop; "Euclid's Elements of Geometry, Books v. and vi.," by H. M. Taylor; "Mechanics and Hydrostatics for Beginners" (this book will include those portions of these subjects which are required for the Matriculation Examination of the University of London, by S. L. Loney); and "Solutions to the Exercises in Euclid, Books i.–iv.," by W. W. Taylor.

Messrs. WHITTAKER AND Co. announce:—Prof. Oliver Lodge's "Treatise on Lightning Conductors and Lightning Guards;" "A Comprehensive Work on the Dynamo," by C. C. Hawkins and F. Wallis; "Coal Pits and Pitmen," by R. Nelson Boyd, M.Inst. C.E.; "Pattern-Making for Students in Technical Schools and Apprentices," by a Foreman Pattern Maker; "Fitting for Engineer Students and others," by the same author; "Electrical Experiments," by G. E. Bonney; "Practical Electric-Light Fitting," by F. C. Allsop; "Electric-Lighting and Power-Distribution," by W. Perren Maycock, M.I.E.E.; "How to Manage a Dynamo," by S. R. Bottone; "The Manufacture of Soap," by W. Lawrence Gadd, F.I.C., F.C.S.; "Ship's Carpentry," by M. and A. Mowat; "Hammered Metal Work," by C. G. Leland, author of "Wood-Carving" and "Leather-Work." In the Library of Popular Science—"Electricity and Magnetism," by S. R. Bottone; "Chemistry," by T. Bolas, F.I.C., F.C.S.; "Geology," by A. J. Jukes Browne, F.G.S.; and other Volumes. An Important Work for Medical Students—"Dissections Illustrated," a Graphic Handbook for Students of Human Anatomy, by C. Gordon Brodie, F.R.C.S., with Plates, carefully drawn and put on the stone by Percy Highley, from dissections of the human body made by the Senior Demonstrator of Anatomy at the Middlesex Hospital Medical School, the first part of which, with 17 coloured plates of the upper limb, two-thirds natural size, will be issued immediately.

In Mr. STANFORD'S list attention is drawn to:—A translation into English by Dr. Hatch of Dr. Theodor Posewitz's work on "Borneo: its Geology and Mineral Resources" (the translator has added a number of references and notes, and four new maps accompany the translation); a new book by Mr. Edward North Buxton, being an account of his adventures in pursuit of large game in various parts of the world (it will be entitled "Short Stalks: or Hunting Camps, North, East, South, and West," and will be accompanied by a number of original illustrations); the paper on "The Fayûm and Lake Mœris," which Major R. Hanbury Brown communicated to the recent Oriental Congress, with photographs by the author, diagrams, and a new map; "Castorologia: or the Traditions of a Canadian Beaver," by Mr. Horace T. Martin, of Montreal (the work will be a handsome octavo, with a number of maps and illustrations); "The Partition of Africa," by Mr. J. Scott Keltie, Secretary to the Royal Geographical Society (it will be brought well up to date, and supplied with an excellent apparatus of maps); and new Editions of the following: "Tanganyika: Eleven Years in Central Africa," by Captain Hore; the late Sir Andrew Ramsay's "Physical Geology and Geography of Great Britain," revised by Mr. W. Topley, F.G.S.; Prof. James Geikie's "Great Ice Age," thoroughly revised; and the late Sir Charles Anderson's "Lincoln Guide," revised by the Rev. A. R. Maddison, Librarian and Succentor of Lincoln Cathedral.

Messrs. BAILLIÈRE, TINDALL AND COX have in the press:—"A Manual of Practical Medical Electricity," by Dawson Turner, M.D., F.R.C.P. Ed., M.R.C.P. Lond.; "The Practical Guide to the Public Health Acts and Correlated Acts for Officers of Health and Inspectors of Nuisances," by Thos. Whiteside Hime, M.B., second edition, enlarged; "Modern Therapeutics, Medical and Surgical, including the Diseases of Women and Children," by Geo. H. Napheys, M.D., ninth edition, revised and enlarged by Drs. Allen Smith and Aubrey Davis, vol. i., Medical; "Diseases of the Throat and Nose," a Practical Guide to Diagnosis and Treatment, with 220 typical illustrations in chromo-lithography and numerous wood engravings, by Lennox Browne, F.R.C.S. Edin., fourth edition.

Messrs. WILLIAMS AND NORGATE will publish:—"Against Dogma and Free Will," by H. Croft Hiller, in which the author wishes to prove from the discoveries of Weismann the impossibility of Free Will, the certainty of Science, and the uselessness of Metaphysics; and in two volumes "The Supernatural: its Origin, Nature, and Evolution," by John H. King, in which the author treats first of the origin and nature of Supernal Concepts, and then of the evolution of the Supernatural in various nations and its modern presentations.

MESSRS. GURNEY AND JACKSON have ready for immediate publication:—"Odorographia," a Natural History of Raw Mateirals and Drugs used in the Perfume Industry, by I. Ch. Sawer, F.L.S.; "The Birds of Lancashire," by F. S. Mitchell, second edition, revised and annotated by Howard Saunders, F.L.S., etc., with additions by R. J. Howard, and other local authorities; a fourth edition of "Destructive Distillation," by Dr. Mills, F.R.S., and a book on "Wild Spain," by Abel Chapman and Walter J. Buck, treating of the beasts and birds of the Peninsula, deer, ibex, chamois, wild boar, and lynx, and bustards, flamingoes, eagles, vultures, game, and wild fowl, with more than 150 illustrations.

MESSRS. SAMPSON LOW AND CO., LIMITED, have in hand:—"The Student's Chemistry," by R. L. Taylor, F.I.C., F.C.S., fully illustrated; and "The Glacial Nightmare," by Sir Henry H. Howorth, M.P., 2 vols.

MESSRS. CASSELL AND CO., LIMITED, announce "The Dawn of Astronomy, by J. Norman Lockyer, F.R.S.; "Beetles, Butterflies, Moths, and other Insects," a brief introduction to their collection and preservation, by A. W. Kappel, F.L.S., F.E.S., and W. Egmont Kirby, with 12 coloured plates; "Cassell's Storehouse of General Information," Vol. III., fully illustrated with high class wood engravings, and with maps and coloured plates; "The Year-Book of Science" (second year of issue), edited by Prof. Bonney, F.R.S., and containing contributions by leading scientific writers; Popular editions of Figuier's works revised by eminent British authorities, "The Insect World," "Reptiles and Birds" (new volumes); and "The Year-Book of Treatment for 1893," a critical review for practitioners of medicine and surgery.

MESSRS. CHAS. GRIFFIN AND CO., LIMITED, will issue "Diseases of the Heart (Diagnosis of)," by A. Ernest Sansom, M.D., F.R.C.P., with 13 plates and illustrations in the text; "Ruptures, a Treatise on," by J. F. C. Macready, F.R.C.S., with numerous plates engraved on the stone after photographs; "Clinical Diagnosis: the Chemical, Microscopical, and Bacteriological Evidence of Disease," by Prof. von Jaksch, of Prague, translated from the third German edition by Jas. Cagney, M.D., with additional illustrations, many in colours, second edition; "The Diseases of Children: Medical and Surgical," by H. Bryan Donkin, M.B., F.R.C.P., and Bilton Pollard, M.D., F.R.C.S.; "Gynæcology," a practical treatise on, by J. Halliday Croom, M.D., with the collaboration of MM. Milne Murray, M.B., and Johnson Symington, M.D.; "Midwifery," a practical treatise on, by John Phillips, M.D.; "A Manual of Obstetrics," for the use of students, nurses, and midwives, by Arch. Donald, M.D.; "Forensic Medicine and Toxicology" (a text-book of), by J. Dixon Mann, M.D., F.R.C.P.; "A Medical Handbook for the Use of Students," by R. S. Aitchison, M.B., F.R.C.P. Edin.; "Inorganic Chemistry" (a Text-Book of), by Dr. Dupré, F.R.S., and Dr. Wilson Hake, second edition, revised; "Mind in Matter," by the Rev. James Tait, third edition, revised and enlarged, with special reference to later Darwinism; "Biology" (a Text-Book of), by Prof. J. R. Ainsworth Davis, new edition, revised and enlarged, in two parts: (1) Vegetable Morphology and Physiology, (2) Animal Morphology and Physiology, with additional illustrations; "Coal Mining" (a Text-Book of), by H. W. Hughes, F.G.S., with frontispiece and 490 illustrations, reduced from working drawings; "Ore and Stone Mining," by Prof. C. Le Neve Foster, D.Sc., with numerous illustrations; "Dyeing" (a manual of), for the use of practical dyers, manufacturers, and students, by Dr. Knecht, Chr. Rawson, and Dr. R. Loewenthal, with numerous illustrations and specimens of dyed fabrics;

"Oils, Fats, Waxes, and Allied Materials, and the Manufacture therefrom of Candles, Soaps, and other Products," by C. R. Alder Wright, D.Sc., F.R.S., with numerous illustrations; "Painters' Colours, Oils, and Varnishes" (a practical Manual), by Geo. H. Hurst, with illustrations; "Applied Mechanics" (an Elementary Manual of), for first year students, by Prof. A. Jamieson, F.R.S.E., with very numerous illustrations; and "Griffin's Electrical Price-Book," for the use of electrical, civil, marine, and borough engineers, local authorities, architects, railway contractors, &c., edited by H. J. Dowsing.

MESSRS. SWAN SONNENSCHEIN AND CO.'s list contains:—"Text Book of Embryology: Man and Mammals," by Dr. Oscar Hertwig, translated and edited from the third German edition by Dr. E. L. Mark, fully illustrated; "Text-Book of Embryology: Invertebrates," by Drs. Korschelt and Heider, translated and edited by Dr. E. L. Mark and Dr. W. M. Woodworth, fully illustrated; "Text-Book of Comparative Geology," adapted from the work of Dr. Kayser, by Philip Lake, fully illustrated; "Text-Book of Palæontology for Zoological Students," by Theodore T. Groom, fully illustrated; "Text-Book of Petrology," by F. H. Hatch, D.Sc., a revised and enlarged edition of "An Introduction to the Study of Petrology," with 86 illustrations; "Handbook of Systematic Botany," by Dr. E. Warming, translated and edited by M. C. Potter, fully illustrated; "Practical Bacteriology," by Dr. Migula, translated and edited by H. J. Campbell, M.D.; "The Geographical Distribution of Disease in England and Wales," by Alfred Haviland, M.D., with several coloured maps; "A Treatise on Public Hygiene and its applications in different European Countries," by Dr. Albert Palmberg, translated, and the English portion edited and revised, by Arthur Newsholme, M.D., fully illustrated; "The Photographer's Pocket-Book," by Dr. E. Vogel, translated by E. C. Conrad, illustrated; "The Recrudescence of Leprosy and the Report of the Leprosy Commission," by William Tebb; "Roaring in Horses: its Pathology and Treatment," by P. J. Cadiot, translated by Thomas J. Watt Dollar, M.R.C.V.S. "Introductory Science Text-Books": additions—Introductions to the Study of "Zoology," by B. Lindsay, illustrated; "The Amphioxus," by Dr. B. Hatschek and James Tuckey, illustrated; "Geology," by Edward B. Aveling, D.Sc. (Lond.), illustrated; "Physiological Psychology," by Dr. Th. Ziehen, adapted by Dr. Otto Beyer and C. C. Vanliew, with 21 illustrations; "Biology," by H. J. Campbell, M.D. "Young Collector Series": additions—"Flowering Plants," by James Britten, F.L.S.; "Grasses," by W. Hutchinson; "Fishes," by the Rev. H. C. Macpherson; and "Mammalia," by the Rev. H. C. Macpherson.

THE SOCIETY FOR PROMOTING CHRISTIAN KNOWLEDGE has nearly ready for publication:—"Star Atlas," gives all the stars from 1 to 6·5 magnitude between the North Pole and 34° south declination and all nebulæ and star clusters which are visible in telescopes of moderate powers, translated and adapted from the German of Dr. Klein, by the Rev. E. McClure, M.A., new edition brought up to date, with eighteen charts and eighty pages illustrative letterpress. "Vegetable Wasps and Plant Worms," by M. C. Cooke, LL.D., illustrated. "Our Secret Friends and Foes," by Prof. Frankland, F.R.S.

MESSRS. LONGMANS AND CO. are preparing for publication:—"The Ruined Cities of Mashonaland: being a Record of Excavations and Explorations, 1891–92," by J. Theodore Bent, F.R.G.S., with numerous illustrations of Mashonaland, and of the author's interesting discoveries of the remains of a prehistoric people at the Zimbabwe ruins. An English translation of Wüllner's "Lehrbuch der Electricität," in 2 vols., translated and edited by G. W. de Tunzelmann, B.Sc., with 310 illustrations. The English editor has added much new matter, and by some changes of arrangement and mode of presenting the subject has endeavoured to make it a truthful representation of the present state of electrical science. "Chemical Lecture Experiments," by G. S. Newth.

MESSRS. LAWRENCE AND BULLEN will publish:—"Matriculation Chemistry," by Temple Orme.

MESSRS. J. AND A. CHURCHILL promise "Physiology" (Student's Guide Series), by E. H. Starling, M.D. Lond., with 100 illustrations; "A Guide to the Science of Photo-micrography," by Edward C. Bousfield, second edition, with 34 woodcuts and frontispiece; "Chemical Technology: or, Chemistry in its application to Arts and Manufactures," with which is incorporated "Richardson and Watts' Chemical Technology," edited by Charles Edward Groves, F.R.S., and William Thorp, B.Sc.: vol. ii. Lighting—Sections: Stearine, by Mr. John McArthur; Candles, by Mr. Field; Oils, Oil Fields, Lamps, by Boverton Redwood; Gas, by Chas. Hunt; Electric Lighting, by Prof. Garnett; "Commercial Organic Analysis," by Alfred H. Allen, F.I.C., F.C.S. A treatise on the properties, proximate analytical examination, and modes of assaying the various organic chemicals and products employed in the arts, manufactures, medicine, &c., with concise methods for the detection and determination of their impurities, adulterations, and products of decomposition. Vol. iii., Part 2, Organic bases, cyanogen compounds, albuminoids, &c. "Wilson's Anatomy," edited by Prof. Henry E. Clark, eleventh edition, with 26 coloured plates, and 492 woodcuts; "Morris's Anatomy," a treatise by various authors: J. B. Sutton, H. Morris, J. N. Davies-Colley, W. J. Walsham, H. St. John Brooks, R. M. Gunn, A. Hensman, F. Treves, W. Anderson, and W. H. A. Jacobson, with more than 500 illustrations, many being coloured; "Ambulance Lectures," to which is added a Nursing Lecture, in accordance with the regulations of the St. John Ambulance Association, by John M. H. Martin, M.D., third edition, with 60 engravings, 142 pp.; and an English edition of Tommasi-Crudeli's well-known work on the Climate of Rome.

Mr. LEWIS'S announcements are:—"Various Forms of Hysterical or Functional Paralysis," by H. C. Charlton Bastian, M.D., F.R.S.; "Diseases of the Skin: Their Description, Pathology, Diagnosis and Treatment," by H. Radcliffe Crocker, M.D., F.R.C.P., second edition, with numerous illustrations; "A Text-book of Ophthalmology," by Dr. Ernest Fuchs, translated from the German by A. Duane, M.D., in one large octavo volume, with 178 illustrations; "Public Health Laboratory Work," by H. R. Kenwood, M.B., with illustrations; "Hygiene and Public Health," by Lucius C. Parkes, M.D., third edition, with numerous illustrations; "A Handbook of the Diseases of the Eye and their Treatment," by Henry R. Swanzy, M.B., F.R.C.S.I., fourth edition, illustrated with wood engravings, colour tests, etc.; "A Pharmacopœia for Diseases of the Skin," edited by James Startin, third edition; and "The Sanitary Inspector's Handbook and Text-book for Students preparing for the Examinations of the Sanitary Institute, London," by Albert Taylor, with illustrations.

Messrs. G. PHILIP AND SON have in the press:—"British New Guinea," a compendium of all the most recent information respecting our Papuan Possession, by J. P. Thomson, with valuable scientific appendix dealing with the Geology, Fauna, Flora, &c., illustrated with numerous engravings and photographs, and a coloured map; "Christopher Columbus," by Clements R. Markham, C.B., forming vol. vii. of the World's Great Explorers and Explorations, with 25 illustrations and numerous coloured maps; "The Development of Africa," a Study in Applied Geography, by Arthur Silva White, illustrated with a set of 14 coloured maps, specially designed by E. G. Ravenstein, F.R.G.S., second edition, revised to April 1892; "Atlas of Astronomy," a Series of Seventy-two beautifully executed Plates, with Explanatory Notes, by Sir Robert Stawell Ball, F.R.S.; "Astronomy for Every-Day Readers," and a Popular Manual of Elementary Astronomy, by B. J. Hopkins, with numerous illustrations.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, Sept. 12.—M. Duchartre in the chair.—On the heat of combustion of glycolic acid, by M. Berthelot.—Note on several new facts relating to the physiology of epilepsy, by M. Brown-Sequard. If by epilepsy is understood a group of reflex convulsive movements, it is invariably induced in guinea-pigs by cutting one of the sciatic nerves. If, however, the section has been made in the lower part of the thigh, the convulsive manifestations often are confined to the side of the lesion, and the animal retains consciousness. This is due to the regeneration of the nerve, which takes place rapidly, and which stops the development of the disease, or even cures it altogether. Generally, the greater the number of nerve fibres severed, the stronger is the tendency towards epileptic fits. A set of absolutely decisive facts have shown that a violent attack can be produced which is due to the spinal marrow alone. This epilepsy as displayed in guinea-pigs is absolutely equivalent to the idiopathic or cerebral disease in man. Clinical as well as experimental facts show that epilepsy has no special seat in the brain, but that all parts of the nervous system, central or peripheral, may give rise to it.—The meadows in the dry summer of 1892, by M. A. Chatin.—Absolute positions and proper motions of circumpolar stars, by M. F. Gonnessiat.—On a problem of analysis involved in the equations of dynamics, by M. R. Liouville.—On a recurring series of pentagons inscribed in the same general curve of the third order, which can be constructed with the sole help of the straight-edge, by M. Paul Serret.—On the calorific distribution of the heat of the sun at the surface of the northern and southern hemispheres of the terrestrial globe, by M. le Goarant de Tromelin. It is sometimes thought that the fact of the sun being eight days longer in the northern hemisphere than in the southern, is the principal cause of the inequality of the distribution of heat in the two hemispheres. It can, however, be shown that the quantities of heat received by two symmetrical elements of the earth's surface, or by two caps symmetrical with respect to the earth's centre, are the same during the durations of the earth's journey comprised between two pairs of opposite vectors. Hence the total heat received by the northern hemisphere during spring and summer is equal to that received by the southern hemisphere during autumn and winter. The true cause of the difference of mean annual temperature in the two hemispheres lies in the difference of loss by radiation. By the law of cooling bodies, if two bodies have the same mean temperature, but different extremes, the one with the greatest extremes will lose most heat by radiation. Thus the southern hemisphere, which is nearer the sun in its summer and further away in its winter than the northern, will lose the greater quantity of heat.—Theory of a condenser interposed in the secondary circuit of a transformer, by M. Désiré Korda.—On the thermal variation of the electrical resistance of mercury, by M. Ch. Ed. Guillaume. The relation between temperature and conductivity was determined by comparing the resistance of a mercury standard of about one ohm at different temperatures with another standard maintained at a constant temperature, with a special arrangement to eliminate the resistances of the contacts. The formula deduced was—

$$\rho_T = \rho_0(1 + 0{\cdot}00088879T + 0{\cdot}0000010222T^2),$$

and the value of the standard mercury ohm—

$$106{\cdot}3 \frac{\text{cm.}}{(\text{microlitre})^{\frac{2}{3}}} \text{ Hg at } 0^\circ.$$

—On a ptomaine obtained from a cultivation of *Micrococcus tetragenus*, by M. A. B. Griffiths. This Micrococcus, found associated with human phthisis, gives rise to a ptomaine if cultivated on peptonised gelatine for several days. This ptomaine is a white solid, crystallizing in prismatic needles. It is soluble in water, giving a feeble alkaline reaction. It forms a chlorohydrate, a chloroaurate, and a chloroplatinate, all crystallizable. Nessler's reagent gives a green precipitate, tannic acid a brown one, slightly soluble. The formula appears to be $C_5H_6NO_2$. It is a poison, and produces death in thirty-six hours. It is undoubtedly the product of the decomposition of the albumin by the microbe.—On echinochrome, a respiratory pigment, by M. A. B. Griffiths. Mr. McMunn discovered a brown pigment in the perivisceral fluid of certain echinoderms in 1883. This was separated by desiccating the fluid and dissolving out by chloroform. The formula of echinochrome is $C_{102}H_{99}N_{12}FeS_2O_{12}$. It serves a purpose in the body of the echinoderm analogous to that of hæmoglobine in the human body, but is not so highly developed as the latter. The respiratory pigments in the lower animals not only carry oxygen to the tissues, but also retain oxygen in combination till taken up by the cellules. Hence echinochrome, like hæmocyanine, chlorocruorine, and similar bodies, is more stable than hæmoglobine.—Physiology of the pancreas, experimental dissociation of the external and internal secretions of the glands, by M. J. Thiroloix.—Influence of some deleterious gases on the progress of anthrax infection, by MM. A. Charrin and H. Roger.—Contribution towards the aseptic method in hypodermic therapeutics, by M. Barthélémy.—On the construction of a luminous fountain with automatically variable colours, by M. G. Trouvé.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—The Locomotive Engine and its Development: C. E. Stretton (Lockwood).—Universal Atlas, Part 18 (Cassell).—Life Histories of North American Birds: C. Bendire (Washington).—Traité Encyclopédique de Photographie: C. Fabre; Premier Supplément (Paris, Gauthier-Villars).—VI. Jahresbericht (1890) der Ornithologischen Beobachtungsstationen im Königreiche Sachsen: A B Meyer u. F. Helm (Berlin, Friedländer).—Elementary Physiography: R A. Gregory (Hughes)—Dynamometers and the Measurement of Power: J. J. Flather (New York, Wiley).—A Manual of Veterinary Physiology: Veterinary Captain F. Smith (Baillière).—Australische Reise: R. v. Lendenfeld (Innsbruck, Wagner).—Medical Microscopy: Dr. F. J. Wethered (Lewis).—A Dictionary of Terms used in Medicine, &c.: R. D. Hoblyn. 12th edition, revised by J. A. P. Price (Whittaker).—The Sea and the Rod: C. T. Paske and Dr. G. Aflalo (Chapman and Hall).—A Lecture Course in Elementary Chemistry: H. T. Lilley (Simpkin).—Modern Science in Bible Lands, popular edition, revised: Sir J W. Dawson (Hodder).—A Handy Book for Brewers: H. E. Wright (Lockwood).—Reports from the Laboratory of the Royal College of Physicians, Edinburgh, vol. iv. (Pentland).—The Fauna and Flora of Gloucestershire: C. A. Witchell and W. B. Strugnell (Stroud, James).—Observations of Double Stars made at the U.S. Naval Observatory, Part 2, 1880-91: Prof. A. Hall (Washington).—Experimental Evolution: Dr. H. de Varigny (Macmillan).—Oriental Cicadidæ, Part 6: W. L. Distant (London).—Paraguay: Dr. E. de B. la Dardye (Philip).—Advanced Building Construction (Longmans).—Transactions and Proceedings of the New Zealand Institute, 1891, vol. xxiv. (Wellington).—Sea-sickness, Voyaging for Health, Health Resorts: Dr. T. Dutton, 3rd edition (Kimpton).—Bulles de Savon: C. V. Boys, traduit de l'Anglais par Ch. Ed. Guillaume (Paris, Gauthier-Villars).—Up the Niger: Capt. A. F. Mockler-Ferryman (Philip).—Earth Burial and Cremation: A. G. Cobb (Putnam).—A Vertebrate Fauna of Lakeland: Rev. H. A. Macpherson (Edinburgh, Douglas).—Contributions to Horticultural Literature: W. Paul (Waltham Cross, Paul).

Pamphlets.—Music in its Relation to the Intellect and the Emotions: J. Stainer (Novello).—Sadi Carnot et la Science de l'Énergie: M. G. Mouret (Paris, J. Carré).—Appendix to the Catalogue of the Flora of Nebraska: H. J. Webber.—Maryland's Attitude in the Struggle for Canada (Baltimore).—Memorial of J. Lovering (Cambridge, Massachusetts, Wilson).

Serials.—Quarterly Journal of Microscopical Science, August (Churchill).—Journal of the Royal Microscopical Society, August (Williams and Norgate).—Transactions of the Academy of Science of St. Louis, vol. v., Nos. 3 and 4 (St. Louis).—Notes from the Leyden Museum, vol. xiv. Nos. 3 and 4 (Leyden, Brill).—Economic Journal, No. 7 (Macmillan).—Journal of Morphology, vol. vi. Nos. 1 and 2 (Boston, Ginn).

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THURSDAY, SEPTEMBER 29, 1892

THE SPEECH OF MONKEYS.

The Speech of Monkeys. By R. L. Garner. (London: Heinemann, 1892.)

IT is somewhat unfortunate, and is certainly not a little embarrassing to the critic who desires to take Mr. Garner seriously, that he has chosen to present to the world "this first contribution to science on the subject" of the speech of monkeys in the form of popular and chatty anecdotes, with reflections thereon suitable for the delectation of elderly spinsters. This is the style of writing to which we refer, and of which the book before us largely consists:—

"I shall long remember how this dear little monk (Pedro the Capuchin) would cuddle up under my chin, and try so hard to make me understand some sad story which seemed to be the burden of his life . . . . I have frequently been entertained by a like speech from little Dodo, who was the Juliet of the Simian tribe. She belonged to the same species as the others, but her oratory was of a type far superior to that of any other of its kind that I have ever heard. At almost any hour of the day, at the approach of her keeper she would stand upright and deliver to him the most touching and impassioned address. The sounds which she used, and the gestures with which she accented them, as far as I could determine, were the same as those used by Dago and Pedro in their remarks to me as above described, except that Dodo delivered her lines in a much more impressive manner than either of the others. . . . . I have not been able up to this time to translate these sounds literally, but their import cannot be misunderstood. My belief is that her speech was a complaint against the inmates of the cage, and that she was begging her keeper not to leave her alone in that great iron prison with all those big, bad monkeys who were so cruel to her."

This is the anecdotal style; the heading of the chapter in which Dodo is introduced running thus: "Dago talks about the Weather—Tells Me of His Troubles—Dodo in the 'Balcony Scene,'" &c. It is not easy, we repeat, to deal with this kind of thing in a spirit of serious criticism. And then we have passages of which the following is a sample:—

"I assert that all mammals reason by the same means and to the same ends, but not to the same degree. The reason which controls the conduct of a man is just the same in kind as that which prompts the ape. . . . That same faculty which guided man to tame the winds of commerce, taught the nautilus to lift its tentacles and embrace the passing breeze. . . . That psychic spark which dimly glows in the animal bursts into a blaze of effulgence in man. The one differs from the other just as a single ray of sunlight differs from the glaring light of noon. If man could disabuse his mind of that contempt for things below his plane of life, and hush the siren voice of self-conceit, his better senses might be touched by the eloquence of truth. But while the vassals of his empty pride control his mind, the plainest facts appeal to him in vain, and all the cogency of proof is lost. He is unwilling to forego that vain belief that he is Nature's idol, and that he is a duplicate of Deity. Held in check by the strong reins of theology and tradition"—and so forth for another page and a half.

These be the reflections suitable for the delectation of elderly spinsters. We must excuse ourselves from criticising Mr. Garner's remarks on reason in animals, for there is no evidence in his book that he has, by a careful training in psychology, earned for himself the right of expressing a scientific opinion on this difficult question.

And yet Mr. Garner is at work upon an interesting and important problem in the elucidation of which scientific results will be of great value; and he is working on the right lines, namely, those of experiment and observation in close contact with phenomena. It is worth while therefore, to dig out from his volume the few results of scientific value he has at present reached, to endeavour to set them in their true light, and to encourage him in the further prosecution of his labours.

It is well known to all observers that animals emit sounds expressive of their emotional states, and that these sounds convey, and are often apparently intended to convey, an intimation to their fellow-creatures of such emotional states. No one who has watched a dog growling, a cat swearing, or a lamb bleating, can question this elementary fact. The present writer has lately been observing and making experiments with young chicks Towards the close of the first week there were at least five well-distinguished sounds: the soft "cheep" of contentment, the more excited note of unusual satisfaction, the complaining "weep-weep" of slight discomfort, the sharper cry when they were caught up, for example, by a strange hand, and, quite distinct from all the rest, the danger "churr." There can be little doubt that these several sounds, as emitted by one of the chicks, were of suggestive value to its little brothers and sisters. And they were quite spontaneous and not the result of imitation, for the chicks had never seen any of their kind. Had these chicks been reared in the ordinary way, and not as experimental orphans, their hen mother would no doubt have given opportunity for observing that by certain sounds she could call her brood's attention to things good to eat. And there can be little doubt that a dog can call its companion's attention to something worriable, though whether there are differentiations, *e.g.*, for cat and rat, we cannot say. We have ourselves been unable to detect such differences in our own dogs.

It is thus a matter of familiar observation that animals emit sounds which are of suggestive value, and that these sounds are in some cases suggestive of emotional states, and in others of external objects. It is to such sounds as emitted by monkeys that Mr. Garner has mainly directed his attention. Let us give in his own words some of his results:—

"Standing near the cage of a little Capuchin, I imitated a sound which I had translated 'milk,' but from many tests I concluded it meant 'food,' which opinion has been somewhat modified by many later experiments which led me to believe that he uses it in a still wider sense. It is difficult to find any formula of human speech equivalent to it. While the Capuchin uses it relating to food and sometimes to drink, I was unable to detect any difference in the sounds. He also seemed to connect the same sound to every kindly office done him, and to use it as a kind of 'shibboleth.' More recently, however, I have detected in the sound slight changes of inflection under different conditions, until I am now led to believe that the meaning of the word depends somewhat, if not wholly, on its modulation."

Again:—

"I approached the cage [of another Capuchin], and uttered the sound which I have described and translated 'drink.' My first effort caught his attention and caused him to turn and look at me; he then arose and answered me with the same word, and came at once to the front of the cage. He looked at me as if in doubt, and I repeated the word; he responded with the same, and turned to a small pan in his cage which he took up and placed near the door, through which the keeper usually passed his food, returned to me, and uttered the word again. I asked the keeper for some milk, which he did not have, but brought me some water instead. . . . I allowed the monkey to dip his hand into the glass, and he would then lick the water from his fingers and reach again. I kept the glass out of reach of his hand, and he would repeat the sound earnestly, and look at me beseechingly, as if to say, 'Please give me some more.' I was thus convinced that the word which I had translated 'milk,' must also mean 'water,' and from this and other tests I at last determined that it meant 'drink' in its broad sense, and possibly 'thirst.' It evidently expressed his desire for something with which to allay his thirst. The sound is very difficult to imitate, and quite impossible to write exactly."

We submit that these passages seem to indicate that Mr. Garner has not yet, in this matter, reached results which have much definiteness and precision. It would seem that the Capuchin emits sounds which are mainly expressive of a craving for something, and perhaps vaguely indicate that this something is water or other drink; though with regard to this objective implication we must remember that one of the capuchins "seemed to connect this sound to every kindly office done him."

This is one of the nine words or sounds belonging to Capuchins. Another is the sound which Mr. Garner has translated "food." Of it he says:—

"I observed that this sound seemed to be a salutation or peace-making term with them, which I attributed to the fact that food was the central thought of every monkey's life, and that consequently that word would naturally be the most important of his whole speech."

Another sound which was emitted by a monkey when a storm was going on, and which, when reproduced by the phonograph, made the little fellow look out of window, Mr. Garner translated "weather," or thought that it "in some way alluded to the state of the weather." But he does not seem quite clear about it.

"I am not sure," he says, "how far it may be relied upon as a separate word. It was so closely connected to the speech of discontent or pain, that I have not been able since to separate the sounds, and I finally abandoned it as a separate word; but reviewing my work, and recalling the peculiar conduct of this monkey and the conditions attending it, I believe it is safe to say that he had in mind the state of the weather."

Three other sounds are plainly emotional in their nature—(1) an alarm sound, used under stress of great fear, high in pitch, shrill and piercing; (2) a sound written thus "e-c-g-k" expressive of apprehension; and (3) a sound which is like a guttural whisper "c-h-I" expressive of the approach of something which the monkey does not fear.

Such are some of the sounds which Mr. Garner misnames (as we think) the "speech" of monkeys, and concerning which he exclaims:—

"Standing on this frail bridge of speech, I see into that broad field of life and thought which lies beyond the confines of our care, and into which, through the gates that I have now unlocked, may soon be borne the sunshine of human intellect. What prophet now can foretell the relations which may yet obtain between the human race and those inferior forms which fill some place in the design, and execute some function in the economy of nature?"

This, however, is one of those reflections which savour of the prattle of the parlour tea-table rather than the sober discussion of the study. We should rather say that Mr. Garner's investigations, if followed up in a spirit of critical accuracy, give promise of enabling him to extend our knowledge of the sounds emitted by monkeys—sounds which, we gather from his descriptions, are mainly, if not entirely, of emotional origin, but which may perhaps carry with them a more or less definite objective import. We are of opinion that such extension of our knowledge of these emotional or other sounds may prove a definite and valuable contribution to science, and we therefore heartily wish Mr. Garner all success in the prosecution of his inquiry. C. Ll. M.

BEE-KEEPING.

Bees for Pleasure and Profit. By G. Gordon Samson. (London: Crosby Lockwood and Son, 1892.)

"HOW doth the little busy bee, &c.?" asked Dr. Watts a hundred and fifty years ago. So long as straw skeps predominated, the problem was insoluble. The bees improved each shining hour in perfunctory fashion, building crooked combs, confusing brood with honey, exhausting their republic with superfluous swarms, dying finally in the smoke-reek of an old pair of corduroys, enriched for malarious exhalation by more than one generation of bucolic wearers. With frame hives came an Earthly Providence to answer the pious query; to control the economy of the hive, to prescribe the number of drones, multiply or restrict the queens, straighten out the combs, combine defective stocks into a single opulent society, disintegrate an overgrown community into new and independent nuclei, supplement the tardy growth of brood or honey, increase fourfold the productiveness of every hive. It is as an adept in Providential operations that Mr. Samson writes. He renounces scientific erudition; and his allusion to "powerful microscopes," his reliance on "wonderful provisions of Nature," his belief that by confining their visits to one kind of flower in a single journey the bees prevent the hybridization of species, show his disclaimer to be correct; but apiarian science was brought up to date last year in Mr. Cowan's admirable book (NATURE, vol. 43, p. 578), leaving room for just such a practical treatise on manipulation and management as Mr. Samson is competent to give.

No repetition can exhaust the interest attaching to the strange life-history of the hive-bees. While the solitary bees are created male and female, there appears in the gregarious bees a third sex, the workers or neuters (not *neutrals*, as Mr. Samson calls them), having rudimentary ovaries and spermatotheca, incapable of laying eggs, with the ovipositor modified into a sting; themselves, in queenless hives, sometimes developed into more advanced yet still imperfect females, known as fertile workers, and producing only drones. In ordinary cases a single queen is the mother of the entire hive, bearing drone eggs only in her virgin state, fecundated once for all by a solitary nuptial act for the production of more than half a million of offspring. During twenty-one days as egg, larva, pupa, the infant bee resides in the comb, fed by its older sisters on a paste of brood-food or chyle, to which in the case of workers honey is added after the first three days. For a week after emergence the young bee remains at home in order to secrete wax, which is detached from the wax pockets by others; it is then promoted to the office of nurse; for a fortnight or three weeks afterwards it gathers honey, spends its maturity in the difficult work of comb-building, dies at the end of six or seven weeks, unless winter hibernation arrests its labour and prolongs its life. The moral of its unique biography has been pointed by many writers; the social lesson of its communistic orderliness, the industrial ideal flowing from its co-operative toil and profit, the political example impressed by the curious completeness with which, at once a red republican and an ardent cavalier, it combines extremest democratic sturdiness with devoted personal loyalty.

The common hive bee, as distinguished from the Bumble, Carpenter, Mason, and other bees, belongs to the genus Apis, of which one species only, *A. mellifica*, is indigenous to Britain. During the last few years the Ligurian, Carniolian, and Syrian bees have been largely introduced, from amongst which the cross known as Syrio-Carniolian bears the palm for fecundity, docility, honey-gathering, and hardiness through the winter. With a swarm of these and a ten-frame hive the tyro may begin bee-keeping. In manipulating he must not wear gloves; they make the fingers clumsy, and the sting, painful at first, causes diminishing inconvenience on each successive infliction, till the system is inoculated by the acid, and the sting is harmless. In creating their new home the bees require assistance; one or two frames of brood-comb from the parent hive, with a limited number of drone cells, must be inserted. As the frames fill, the master, utilizing the fact that honey is always stored above the brood, places "supers" over the frames, removing them as fast as they are filled, while the full-charged combs from below are placed in an extractor and the liquid honey is withdrawn. As much as 100 pounds of honey have sometimes been thus obtained in one season from a single hive. The honey harvest begins with the blooming fruit trees in early spring, and slackens after the lime trees fade, but in heather districts a rich autumn store is raised, and Scottish bee-keepers, having reaped the early crop from bean and clover, send their hives by rail or boat to a considerable distance, to be placed upon the heath-clad moors in early August. When an unfavourable winter has depopulated the hives, it is possible to build up one strong colony out of two or more weak stocks, retaining only the youngest and most prolific queen. The bees will resent the coalition, and a general fight will impend; but if sprinkled with thin syrup and with flour their power of discerning Trojan from Tyrian is cancelled by the identity of appearance and of scent.

> "Just so the prudent husbandman, that sees
> The idle tumult of his factious bees,
> Powders them o'er, till none discern his foes,
> And all themselves in meal and friendship lose.
> The insect kingdom straight begins to thrive,
> And all work honey for the common hive."

Mr. Samson does well to press the economic value of bees not only as honey-makers, but as fruit-setters. In cold sunless springs their agency is essential to the fertilization of the bloom; in districts adjoining a large apiary the fruit trees are invariably laden with heavy crops, deteriorating as we remove further from its neighbourhood; and instances are well authenticated from the cider counties in which a general destruction of bees by a long and variable winter has been followed by the loss of the apple crop. Both fruit and honey are at present for the most part imported from abroad; if fruit is to be largely cultivated in the small holdings of the future, it must be sustained and enriched by bee-keeping.

In this, as in other industries, there are occasional difficulties baffling to all but experts. Queens will refuse to be reared, supers will remain unfilled, stocks will need stimulation in the spring and building up in early winter, foul brood, deadliest of bee maladies, will infect the hive. In all such complications and for many more Mr. Samson offers full and clear instruction. Portable in form and cheap of cost, his book should form part, along with "smoker," bee veil, queen cage, "driving irons," and "doubling box," of every bee-keeper's equipment.

W. TUCKWELL.

A NEW COURSE OF CHEMICAL INSTRUCTION.

A New Course of Experimental Chemistry, with Key. By John Castell-Evans, F.I.C. (London: Thomas Murby.)

THE basis of the course of instruction here put forward consists in making the student perform an experiment with a definite object in view. The result of the experiment is carefully withheld, and must be discovered by the student himself. In this way he is led to acquire knowledge by his own exertions, and theoretically at least such a method has more to recommend it than any other. In practice, however, the time required to rigorously carry out this system is no doubt an obstacle to its general adoption.

If with the author we lay down the law that "the student must not be allowed to use any chemical *name* or *term* until he has discovered for himself the *thing* or *process* represented by it," to acquire but a moderate knowledge of the chemistry of to-day appears well-nigh an impossibility. It was thus a matter of interest to see how a work based on this system could be comprised within reasonable limits of space. The author, however, does not seem to intend the above restriction to be literally enforced. To go no further than the first lesson, we find the student employing the ordinary chemicals, phosphorus, ammonium nitrite, potassium chlorate, &c., things which he makes no attempt to discover; only in the case of the more important processes and substances usually met with in a chemical course is any such attempt made.

The book consists of two parts. The first part contains a series of experiments and problems; the latter being set upon a course of lectures which are intended to be given concurrently with the laboratory instruction, and which deal more especially with the physical aspect of the subject. Outlines of these lectures, results of the experiments, and full solutions of the problems are to be found in the Key, which may be obtained separately or bound up with the two parts. The experiments start off with the commonly occurring phenomena of combustion, and lead up to the laws of chemical combination, the determination of chemical equivalents, vapour densities, &c.

Part II. consists of qualitative and quantitative analysis taken together, no attempt being made to separate the two. The results of the experiments are here carefully withheld from the student, and are given in the Key. A useful table for the detection of the positive radicles is published separately, and may be used in connection with this part.

The book can be recommended as a trustworthy one, and, apart from the novelty of the system adopted, as a storehouse of knowledge useful to the chemist, it will be appreciated by many a teacher.

The problems are actual examples met with in the laboratory, and appear to be free from the artificial exercises so common in text-books. It is also noteworthy that they, as well as the lectures, are concerned to a considerable extent with the energy changes as well as with the material changes which constitute chemical phenomena.

In glancing at the tables of physical constants to be found as answers in the Key, it is frequently noticeable that these magnitudes are given to an accuracy which is altogether fictitious. For example, to express heats of vaporization or absorption coefficients to one part in thousands of millions, or to give a boiling point such as that of bromine to one thousandth of a degree Fahrenheit, tends to create an erroneous idea of the accuracy with which such determinations can be made. In one or two instances the information is not quite up to date. Hydrofluoric acid, for instance, is still formulated H_2F_2, and Bunsen's values for the absorption coefficients of hydrogen and oxygen are still given, although they have been superseded by the observations of Winkler and Timoféef. Van der Waals's work might have been included in the otherwise serviceable account of the kinetic theory of gases, and it is somewhat unfortunate that the author insists upon the narrow view that specific gravity has no other meaning than that which is perhaps more correctly attributed to relative density.

The printing and the woodcuts are hardly up to the standard usually attained in books of this kind.

J. W. R.

OUR BOOK SHELF.

Die Pflanze in ihren Beziehungen zum Eisen. Von Dr. Hans Molisch. Iron in its Relations to Plant-life. 8vo, 119 pages, with one coloured plate. (Jena: Gustav Fischer, 1892.)

AN interesting essay on the presence, function, and form of iron in plants, embodying the results of previous investigators and of the author's experiments and researches extending over several years. Though the outcome of much labour, Dr. Molisch regards it as preliminary to more extended inquiries, and the whole subject as being yet in its infancy. He discusses the determination of the presence in the vegetable cell of iron in loose combinations and in dense combinations, or what he terms the masked condition. He then describes the occurrence and distribution of iron in plants in loose and dense combinations, and enters somewhat fully into the description of a new method he claims to have discovered for proving the existence of iron in the masked condition, even when it is present only in infinitesimally small quantities. This is done by soaking the objects one or more days or weeks in saturated aqueous liquor potassæ, and then, after quickly washing them in pure water, subjecting them to the usual reagents. He further claims to have proved that iron is not one of the constituents of chlorophyll. There is also a short chapter on healing vegetable chlorosis by the use of chloride of iron, sulphate of iron, and other salts of iron.

W. B. H.

Up the Niger. By Captain A. F. Mockler-Ferryman (London: George Philip and Son, 1892.)

SEVERAL years ago complaints were made about the conduct of various British subjects in the territories placed under the Royal Niger Company. The British Government accordingly sent Major Claude Macdonald to inquire into the matter. He was accompanied by Captain Mockler-Ferryman, who in the present volume gives a full account of the proceedings of the Mission. During the entire journey, which extended over more than 3000 miles, nothing "of a blood-curdling nature" occurred, so that any one who is attracted to books of travel mainly by the chance of finding them full of sensational narratives, need not trouble himself with Captain Mockler-Ferryman's pages. On the other hand, those who like to read about remote regions and their native inhabitants, will find in this book much to interest them. The author is an accurate observer, and notes in a clear and unpretending style the facts by which his attention has been most strongly attracted. His descriptions of the native tribes of the Niger country, so far as he himself observed them, are particularly good, and will not only please the general reader, but be of service to ethnologists and anthropologists. A capital chapter on music and musical instruments, prepared from materials collected by the members of the mission, is contributed by Captain C. R. Day, and the value of the volume as a whole is much increased by a map and illustrations.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Density of Nitrogen.

I AM much puzzled by some recent results as to the density of *nitrogen*, and shall be obliged if any of your chemical readers can offer suggestions as to the cause. According to two methods of preparation I obtain quite distinct values. The relative difference, amounting to about $\frac{1}{1000}$ part, is small in itself; but it lies entirely outside the errors of experiment, and can only be attributed to a variation in the character of the gas.

In the first method the oxygen of atmospheric air is removed in the ordinary way by metallic copper, itself reduced by hydrogen from the oxide. The air, freed from CO_2 by potash, gives up its oxygen to copper heated in hard glass over a large Bunsen, and *then* passes over about a foot of red-hot copper in a furnace. This tube was used merely as an indicator, and the copper in it remained bright throughout. The gas then passed through a wash-bottle containing sulphuric acid, thence again through the furnace over *copper oxide*, and finally over sulphuric acid, potash, and phosphoric anhydride.

In the second method of preparation, suggested to me by Prof. Ramsay, everything remained unchanged, except that the *first* tube of hot copper was replaced by a wash-bottle containing liquid *ammonia*, through which the air was allowed to bubble. The ammonia method is very convenient, but the nitrogen obtained by means of it was $\frac{1}{1000}$ part *lighter* than the nitrogen of the first method. The question is, to what is the discrepancy due?

The first nitrogen would be too heavy, if it contained residual oxygen. But on this hypothesis something like 1 per cent. would be required. I could detect none whatever by means of alkaline pyrogallate. It may be remarked the density of this nitrogen agrees closely with that recently obtained by Leduc, using the same method of preparation.

On the other hand, can the ammonia-made nitrogen be too light from the presence of impurity? There are not many gases lighter than nitrogen, and the absence of hydrogen, ammonia, and water seems to be fully secured. On the whole it seemed the more probable supposition that the impurity was hydrogen, which in this degree of dilution escaped the action of the copper oxide. But a special experiment appears to exclude this explanation.

Into nitrogen prepared by the first method, but before its passage into the furnace tubes, one or two thousandths by volume of hydrogen were introduced. To effect this in a uniform manner the gas was made to bubble through a small hydrogen generator, which could be set in action under its own electromotive force by closing an external contact. The rate of hydrogen production was determined by a suitable galvanometer enclosed in the circuit. But the introduction of hydrogen had not the smallest effect upon the density, showing that the copper oxide was capable of performing the part desired of it.

Is it possible that the difference is independent of impurity, the nitrogen itself being to some extent in a different (dissociated) state?

I ought to have mentioned that during the fillings of the globe, the rate of passage of gas was very uniform, and about $\frac{2}{3}$ litre per hour.

RAYLEIGH.

Terling Place, Witham, September 24.

Recent Spectroscopic Determinations.

IN the September number of the *Philosophical Magazine* Mr. Michelson has published determinations, by a most interesting method, of very close double and multiple lines. In any attempt to interpret his results, it is neccesary to bear in mind the profound modifications which the internal motions of a gas—the rectilinear motions of the molecules between their encounters, as well as the motions going on within each molecule—had undergone within the Geisler's tubes upon which he experimented.

In a gas under ordinary circumstances the rectilinear journeys of the molecules take place indifferently in all directions, and where this is the case it follows from the well-known relation between the surface of a sphere and that of its circumscribing cylinder, that the effect of the velocities which happen to lie between ν and $\nu + \delta\nu$ is to substitute for each line of the spectrum of the gas a band of uniform intensity and without nebulous edges, the width of which can be calculated. This width, for example, is ·04 of an Ångström or Rowland unit (the tenthetmetre), in the yellow part of the spectrum and for velocities of the molecules which lie in the neighbourhood of two kilometres per second, which is about the average velocity of molecules of hydrogen at atmospheric temperatures. Hence with all the velocities that prevail among the molecules, the effect of the rectilinear motions under ordinary circumstances is that each line will be symmetrically widened and rendered nebulous. To this effect Mr. Michelson calls attention.

But in the residual gas of a Geisler's tube through which electricity is passing, the case is altogether different. Here the rectilinear motions of the molecules are not alike in all directions, but preponderate in some: a state of things which must at least double the lines, and may introduce greater complications.

Moreover, different lines may be differently affected, since the behaviour of the gas varies according to its position between the electrodes; as is evidenced by the observed differences in the form and colouring of the striæ, &c., in the several parts of a Geisler's tube.

We must also be on our guard in another respect, when we attempt to interpret the results, since the distribution of the heat energy of a gas between the rectilinear motions of its molecules and the motions within the molecules, which in the case of ordinary gas is a fixed ratio, is certainly largely departed from in gas through which electricity is passing. Until the laws of the new distribution are understood, the temperature of the gas, judged of by its behaviour to neighbouring bodies, will give us little information.

It is to such events as are referred to above, or others which like them may arise from the special circumstances under which the vapour of sodium was in Mr. Michelson's experiments, that we must apparently turn for an explanation of the doubling of the constituents of the principal pair of sodium lines which he has detected; since he found that "the width of the lines, their distances apart, and their relative intensities vary rapidly with changes in temperature and pressure."

The method of investigation which Mr. Michelson has so successfully applied appears to be by far the most searching means yet discovered of experimentally investigating the intricate and obscure phenomena which present themselves in Geisler's tubes, and we seem justified in hoping for great results from it.

G. JOHNSTONE STONEY.

9, Palmerston Park, Dublin, September 22.

Printing Mathematical Symbols.

EVERYONE who has had to correct printers' proofs of mathematical formulæ must be painfully alive to the pitfalls into which the non-mathematical compositor continually blunders. To such as know the extreme difficulty of getting such formulæ properly set up, there have doubtless occurred from time to time suggestions for such simplifications of notation as shall render the composition less liable to derangement. One most sensible step of the kind I allude to is the introduction by Sir G. Stokes of the solidus notation for quotients, whereby

$$\frac{dy}{dx} \text{ is now written } dy/dx.$$

The immediate purpose of this letter is not to propound any wholesale scheme of reform, but to advocate one other simple step, and to induce some of my *confrères* to give the world their own suggestions.

Exponentials are a continual stumbling-block to the compositor, and to the printer's reader, who, when he comes to an expression like

$$\mathrm{A}\epsilon^{-ax},$$

does his best to make it look a little straighter and turns it into

$$\mathrm{A}\epsilon - ax,$$

or into

$$\mathrm{A}_\epsilon - ax,$$

or perhaps worse.

The reform I advocate is to write the thing as follows:—

$$\mathrm{A}\ exp[-ax],$$

the square brackets being possibly omitted in all cases when their omission would occasion no confusion. One gain in this notation is the reduction of the whole of the symbols to one level, so not breaking the line of type.

Another useful reform, though one on which I fear the probability of agreement is less likely, is the use of the Continental notation for inverse trigonometrical functions, writing, for example,

$$\text{arc} \tan x,$$

instead of

$$\tan^{-1} x$$

for the angle whose tangent is x. Our notation is not only liable to continual misprinting, but is very confusing to Continental readers, who again and again read the latter expression as meaning

$$(\tan x)^{-1}, \text{ or } \cot x.$$

I have even seen it reprinted in a German technical journal as

$$\tan - 1x.$$

SILVANUS P. THOMPSON.

Technical College, Finsbury, September 22.

A so-called Thunderbolt.

DURING a short storm in Liverpool this summer, I noticed one flash as peculiarly sharp and noisy, and subsequently in the correct bearing from my house the ground was reported as having been struck by a thunderbolt. I examined the place, which was on the greensward of a lake, where the ground was penetrated by a number of fairly clean-cut almost vertical holes down which a walking-stick could be thrust. People sheltering near the lake reported a ball of fire and a great splash up of the water. The odd circumstance about the damage was that it occurred on a simple grass slope, about half way between a tall boat-house on the one side and a drinking fountain standing on more elevated ground on the other. Small trees also were in the neighbourhood, and there was no apparent cause why the flash should have selected this particular spot; though indeed it was not within any of the ordinarily accepted "areas of protection." A gentleman—Mr. Hewitt—proposed digging for the meteor, and although fairly convinced that it was nothing but an ordinary flash, we thought it just possible that an accidental meteorite might have fallen during the thunderstorm; in which event a flash down the rarefied air of its trail would be a natural consequence. It may be just possible that the popular belief in thunderbolts has some such foundation.

At any rate the excavation was made, with the result of proving that it was an ordinary flash and that the lightning made use of a surface drain-pipe, about four feet deep, to get at the water of the lake.

I enclose Mr. Hewitt's report. Oliver J. Lodge.

During a thunderstorm on the afternoon of Sunday, July 3, 1892, what is described as a "ball of fire" was seen by several persons to descend to the ground, near the south end of the lake in Sefton Park; and immediately afterwards a column of water, about sixty feet high, was shot up from the lake. On examining the spot where the ball of fire was seen to descend, several clean-cut holes were observed, and a sod was also found at a little distance from the spot.

A few days afterwards an excavation was carefully made. The sod being removed, the holes were traced down to a surface drain pipe four feet below the surface. At this drain the holes terminated, and the pipe was found shattered. The important holes were found to be six, the largest being seven inches in diameter, the others about two inches. No meteoric matter was found, but it seems curious that this effect was brought about by a flash of lightning only, in an open space of sloping grass, when there were trees and houses close by.

Aigburth, Liverpool. George H. Hewitt.

Peripatus Re-discovered in Jamaica.

Mrs. E. M. Swainson has been so fortunate as to find on Beacon Hill, near Bath, three specimens of *Peripatus*, which she has sent to the Institute of Jamaica. The species is doubtless identical with that found by Gosse many years ago at the other end of the island. Of the two specimens which we have studied, one has 36 pairs of legs, and is dark pinkish-brown, with the ends of the antennæ pure white, in striking contrast; the other is smaller and darker, without white ends to the antennæ, and with only 29 pairs of legs. The third example, which we have still alive, is larger, but dark in colour. Full details will be given elsewhere later on, and it may suffice for the present to state that the species is very closely allied to *P. Edwardsii* from Venezuela, as described by Sedgwick, but differs in the greater number of legs and the white-tipped antennæ of certain individuals (probably the females), in the only slightly curved (not hooked) claws, in the differentiation of the papillæ into two distinct kinds on the dorsal surface, and apparently in other minor matters. There is no dark dorsal line. The genital orifice is between the penultimate pair of legs; and the jaws are almost precisely as in *Edwardsii*. The Jamaican species being evidently new, it is proposed to call it *Peripatus jamaicensis*.

M. Grabham.
September 5. T. D. A. Cockerell.

Reflection on Valley Fog.

A letter from an observer at the Lick Observatory appeared in Nature on August 25, reporting the reflection of mountains in a valley fog. I was therefore much interested to note the following in the *Yorkshire Herald* of September 7:—

"Sir,—Possibly it may interest your readers to hear of a natural phenomenon I noticed this morning before 6 a.m. Overlooking, from Leyburn, the valley of Wensleydale, it appeared as though more than half of the dale was filled with water, like a great lake with rising hills on either side, and these hill-sides, above the level of the (apparent) flood, were distinctly reflected in it. The sun was shining brightly at the time, but almost immediately the mist began to disperse, and the mirage faded away. What struck me as unusual was the extraordinary distinctness of the reflection. Yours, An Early Riser. September 5, 1892."

In both cases the reflecting film seems to have been near its vanishing point. J. Edmund Clark.

Impure Water in Bread.

Some accurate answers to the following questions would be desirable, in view of public health.

(1) What bacilli—if any—can survive in the amount and duration of the heat of baking in the interior of unfermented bread?

(2) What is the further effect of the carbonic acid of fermentation?

(3) What is the effect of the water being highly carbonated without fermentation, as in aerated bread?

W. M. F. P.

The Comets of Brorsen (1846 VII.) and Brooks (1892 "*d*").

The elements of Brooks's comet "1892 *d*," as computed by Berberich from four observations made between August 31 and September 5, bear a strong resemblance to those of Brorsen's comet of 1846, calculated by Oudemans, the figures being—

	Comet Brorsen (1846 VII.)	Comet Brooks (1892 *d*)
T	1846 June 5·479	1892 Dec. 19·727
	° ′ ″	° ′ ″
ω	260 12 50	269 24 27
☊	261 53 12	261 2 55
i	29 18 47	27 57 8
Log q	9·80188	9·84455

Brorsen's comet of 1846 was visible to the naked eye on May 14 of that year. It was supposed to be revolving in an elliptical orbit, with a period of about 400 years. W. F. Denning.

Bristol, September 22.

NOTE ON THE PROGRESS OF THE DIOPTRIC LENS AS USED IN LIGHTHOUSE ILLUMINATION.

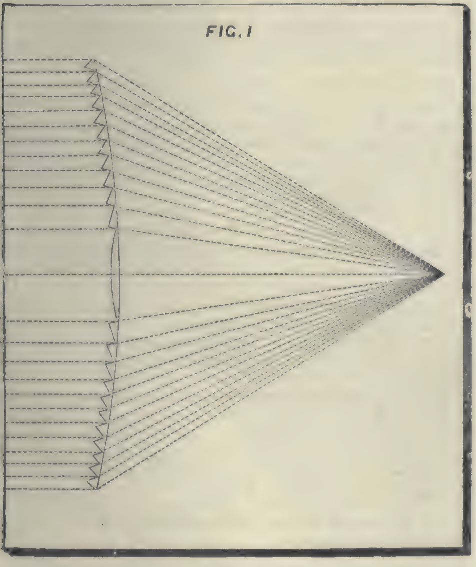
Fresnel, in 1820, devised and constructed a lens for first order lights of 920 mm. radius. It was composed of a plano-convex lens, with five refracting prisms concentric with it, and four segments of rings in the corners all gradually decreasing in breadth as they receded from the centre. The separate pieces of which these lenses were made up were cemented together and mounted in metallic frames 30 inches square.

In 1835, the late Mr. Alan Stevenson introduced the French apparatus into Great Britain. In doing so he made several improvements, one of which was that he increased the height of the lens from 30 to 39 inches, at the same time diminishing the thickness of the glass. This refractor had eight prisms above and eight prisms below the central lens. From that time Alan Stevenson's lens was almost universally used until a comparatively recent date, when a revolution in the size of lenses took place.

A few years ago inventors were trying to obtain greater power by increasing the diameter and volume of the flames; but Messrs. Stevenson pointed out, in 1869, that after a certain point an increase of diameter of the luminary not accompanied by a corresponding increase of the radius of the apparatus was a mistake, as the light became ex-focal and divergent, and that the proper way to secure greater power was to enlarge the *diameter* of the apparatus. In 1885 they had a lens made to their design of 1330 mm. radius, and having a height of 5 feet. This lens, which was named "Hyper-radiant," was tried at the South Foreland against other lenses, and with a large 10-ring gas burner it was found to give a light from one and a half to twice as intense as the ordinary lenses which were pitted against it, with the same large burners in their foci, thus proving conclusively that to get the power out of large burners it was imperatively necessary to increase the diameter of the apparatus. In 1883 Messrs. Stevenson got an offer from Messrs. Barbier for a lens of 1840 mm. focal distance.

All refracting lenses from the day of Alan Stevenson were cylindrical for fixed lights and plano-convex for revolving lights, and no alteration of any moment has been made in the mode of their construction until 1888, when, instead of making the lenses cylindrical or plano-convex, I proposed to give them a spherical form, that is to say, circular not only in the horizontal but also in the vertical section. This design was carried into practice in the apparatus for one of the Fair Isle Lighthouses. The introduction of the spherical refractor has made practicable the construction of very much larger and consequently more powerful apparatus, and occupying much less space both in the daylight size and diameter of lantern, and, hence, diameter of tower. It has rendered practicable the quadrilateral arrangement with hyper-radiant lenses which have already been erected at Fair Isle, the lenses being cut so as to give two flashes from each side of the quadrilateral. An experimental lens made for Mr. Wigham is to be tried in Ireland. It is 2m. focal distance, and the spherical refractor is 7 feet 6 inches diameter, and will give one flash from each side of the quadrilateral. M. Barbier says that in making this lens he was attempting to give the most powerful flash possible, and he adopted the spherical refractor. In this case, however, the spherical refractor has been carried, in my opinion, rather far, except in the view of economy in keeping the angles of the whole apparatus within reasonable limits, which is only possible (in an apparatus of 4m. diameter) by the use of the spherical refractor, and by its being made to subtend a great angle. When I proposed this form I pointed out that there was a loss of efficiency if it subtended more than 40°; now M. Barbier has made the spherical portion subtend 64°, or 24° farther, and 8° farther than any spherical refractor yet made. The great amount of light which I experimentally found returned from the inner face of the spherical refractor made for Fair Isle, however, shows that up to 20°, and perhaps farther, it is ample to make up for any loss of light caused by the greater divergence which takes place *in* the spherical refractor, and which would be a *small* source of loss in a revolving light, but would better illuminate the nearer sea in a fixed arc.

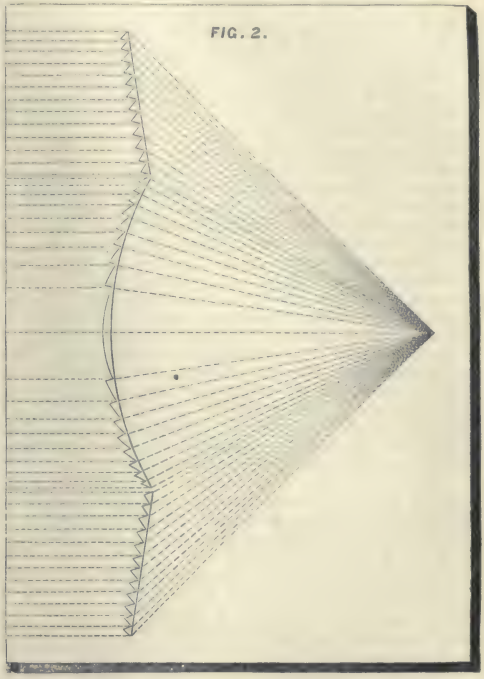
FIG. I



Equiangular Refractor.

To obviate the loss of light at the outer face of the lenses, especially those remote from the focal plane—a loss which stops the refractor being carried with due regard to efficiency farther than 30° to 40° in the cylindrical form, and 20° in the spherical form—it will be found that the most efficient form is a refractor which I proposed, with the inner face of each lens doing equal work with the outer face, or nearly so—and by a careful study of such a refractor it will be found that the locus of the centres of curvature of each refracting lens lies outside the refractor, and at points below the focal plane, and more and more remote from the lens, as the lenses are more and more remote from the focal plane, and that the inner face of the refractor ought, in fact, to be a parabolic curve (Fig. 1). This can very closely be approximated to by a circular curve with a suitably chosen centre on the focal line produced, but the centre is so far distant that when the spherical form and the equiangular form are used in combination (Fig. 2), the inner face of the equiangular prisms above and below it may, with sufficient accuracy, be made straight and leaning outwards in place of being vertical as in Fresnel's form. By the combination of the spherical refractor and the equiangular, or a refractor of the equiangular form alone, the defect in Fresnel's refractor, namely the loss of light at emergence from the lenses, especially those remote from the focal plane, is avoided, and the refractor may thus be made to subtend an angle which has hitherto been considered inexpedient, with glass of the ordinary

FIG. 2.



refractive index of 1·53. The equiangular prisms cause less loss of light by absorption and reflection than either the spherical or Fresnel refractors, and also act on the light so that ex-focal light is better dealt with, thereby reducing the divergence.

CHARLES A. STEVENSON.

MODERN DYNAMICAL METHODS.

A DYNAMICAL system is said to possess a *given* number of degrees of freedom, when it is capable of assuming the *same* number of independent positions. The position of the system, in any possible configuration, is capable of being determined by a definite number of independent quantities, which are equal to the number of degrees of freedom of the system. These quantities are called the co-ordinates of the system.

When the system possesses *six* degrees of freedom, the motion may be completely determined by expressing in mathematical language a principle which may be conveniently termed the *principle of momentum.* This principle is specified by the following two propositions:—(i.) *The rate of change of the component of the linear momentum, parallel to an axis, of any dynamical system, is equal to the component, parallel to that axis, of the impressed forces which act upon the system;* (ii.) *the rate of change of the component of the angular momentum about any axis, is equal to the moment of the impressed forces about that axis.* Since the motion of the system may be referred to any set of fixed or moving rectangular axes, the above-mentioned dynamical principle furnishes six equations connecting the six co-ordinates, which, when integrated, will determine the latter in terms of the time and the initial circumstances of the motion.

The various ways of expressing this dynamical principle in mathematical language are explained in treatises on dynamics: and a variety of special forms and particular cases are obtained, by means of which the solution of numerous problems can be simplified. For example, Euler's equations, for determining the motion of rotation of a single rigid body about its centre of inertia, is a particular case of the second proposition; whilst Kirchhoff's equations, for determining the motion of a single solid in an infinite liquid, is a special form of both propositions.

When a conservative system possesses seven degrees of freedom, the motion may be completely determined by means of the principle of momentum combined with the principle of energy. The first principle, as we have already shown, furnishes six equations, whilst the second furnishes one; hence, we have a sufficient number of equations for determining the motion.

When a dynamical system possesses more than seven degrees of freedom, the principles of momentum and energy are insufficient to determine the motion; and under these circumstances, the most convenient method to adopt is to use Lagrange's equations; but inasmuch as these equations are double-edged tools, which are apt to cut the fingers of the unwary, their employment requires considerable care.

The kinetic energy of a dynamical system can be expressed in a variety of different forms, but it will only be necessary to mention the following three. In the first form, it is expressed as a homogeneous quadratic function of velocities, which are the time-variations of the co-ordinates of the system. This form, which will be denoted by T, is called the *Lagrangian form;* it is the only one which it is permissible to use when employing Lagrange's equations, and many mistakes have been made by persons who have attempted to use some other form.

In the second form, which is called the *Hamiltonian form,* the kinetic energy is expressed as a homogeneous quadratic function of the momenta of the system. If θ be any co-ordinate, and Θ the generalized momentum of type θ, it is known that

$$\frac{\partial T}{\partial \dot{\theta}} = \Theta \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

whence Θ is a linear function of the velocities. Hence, if the velocities be eliminated from the Lagrangian expression for the kinetic energy by means of (1), it follows that the latter will be expressible as a homogeneous quadratic function of the momenta Θ, which is the Hamiltonian form. We shall denote this form by $\mathcal{T}$.

Lagrange's equations are

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{\theta}}\right) - \frac{\partial T}{\partial \theta} = -\frac{\partial V}{\partial \theta} \quad . \quad . \quad . \quad . \quad (2)$$

where V is the potential energy; and if the elimination be performed, we shall obtain

$$\frac{d\Theta}{dt} + \frac{\partial \mathcal{T}}{\partial \theta} = -\frac{\partial V}{\partial \theta} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

we have also the reciprocal relation

$$\frac{\partial \mathcal{T}}{\partial \Theta} = \dot{\theta} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Equations (3) and (4) are Hamilton's equations of motion.

The third form of the expression for the kinetic energy is of special importance in hydrodynamics and other branches of physics. It sometimes happens that a quantity occurs which can be recognized as a momentum, or as a quantity in the nature of a momentum, whilst the velocity corresponding to this momentum is either unknown or would be inconvenient to introduce. This occurs in problems relating to the motion of perforated solids in a liquid, when there is circulation, and is a particular case of Dr. Routh's theory of the "Ignoration of Velocities."[1] We therefore require a form of Lagrange's equations in which certain velocities are eliminated, and are replaced by the corresponding momenta.

Let the co-ordinates of the system be divided into two groups, θ and χ; and let κ denote the generalized momentum corresponding to χ. Then

$$\frac{\partial T}{\partial \dot{\chi}} = \kappa \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

By means of (5) all the velocities $\dot{\chi}$ can be eliminated from the expression for the kinetic energy; and it is remarkable, that the result of the elimination does not contain any products of the form $\kappa\dot{\theta}$. The expression for T may accordingly be written

$$T = \mathfrak{T} + \mathfrak{K} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where $\mathfrak{T}$ is a homogeneous quadratic function of the velocities $\dot{\theta}$, and $\mathfrak{K}$ is a similar function of the momenta κ.

Equation (6) is therefore a mixed form, which is partly Lagrangian and partly Hamiltonian. We now require the corresponding form of the equations of motion in which all the $\dot{\chi}$'s have been eliminated from Lagrange's equations.

From (1) it follows that the generalized momentum Θ is a linear function of the velocities $\dot{\theta}, \dot{\chi}$; and if the latter velocities be eliminated by means of (5), it follows that Θ is expressible as a linear function of $\dot{\theta}, \kappa$. Let the portion which is a linear function of the κ's be denoted by $\overline{\Theta}$; then it can be shown, that if

$$L = \mathfrak{T} + \Sigma(\overline{\Theta}\dot{\theta}) - \mathfrak{K} - V \quad . \quad . \quad . \quad . \quad (7)$$

the equation of type θ is

$$\frac{d}{dt}\frac{\partial L}{\partial \dot{\theta}} - \frac{\partial L}{\partial \theta} = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

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[1] Having regard to the object of the theory, I think the phrase "Ignoration of Velocities" is better than "Ignoration of Co-ordinates."

whilst that of type χ is

$$\frac{d\kappa}{dt} - \frac{\partial L}{\partial \chi} = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

We have also the additional equations

$$\Theta = \frac{\partial \mathfrak{T}}{\partial \dot{\theta}} + \bar{\Theta} \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

$$\dot{\chi} = \frac{\partial \mathfrak{K}}{\partial \kappa} - \Sigma\left(\dot{\theta} \frac{\partial \Theta}{\partial \kappa} \right) \quad . \quad . \quad . \quad . \quad (11)$$

Equations (7) to (11) were first given by myself in a paper published in the Proc. Camb. Phil. Soc. for 1887; and it will be observed that they include the equations of Lagrange and Hamilton. A form of the modified Lagrangian function, which is equivalent to (7), was given by Dr. Routh a few years previously; but it is not of much practical use, owing to the fact that the elimination of the velocities $\dot{\chi}$ has not been performed.

It sometimes happens that the *co-ordinates* of the type χ do not enter into the expression for the energy of the system, in which case they are called *ignored co-ordinates*;[1] under these circumstances it follows from (9), that all the momenta κ are absolute currents. A top spinning about its point under the action of gravity is one of the most familiar examples of ignored co-ordinates, and one which illustrates several important dynamical theorems.

When there are ignored co-ordinates, the steady motion of the system, and the stability of the steady motion, can very easily be investigated. For if we suppose that all the co-ordinates θ have constant values, (8) reduces to

$$\frac{\partial \mathfrak{K}}{\partial \theta} + \frac{\partial V}{\partial \theta} = 0.$$

There are as many equations of this type as there are co-ordinates θ, and an examination of this system of equations will show whether steady motion is possible, and if so, will determine the necessary conditions which the co-ordinates θ and the constant momenta κ must satisfy.

It can also be shown that the steady motion will always be stable when $\mathfrak{K} + V$ is a minimum (see Proc. Camb. Phil. Soc. May 1892).

We have therefore the following simple rule for determining the steady motion of a dynamical system when there are ignored co-ordinates. Eliminate all the velocities corresponding to these co-ordinates from the expression for the kinetic energy of the system, so that the latter is expressed in terms of the velocities $\dot{\theta}$ and the momenta κ. Let $\mathfrak{K}$ and V be that portion of the *total* energy which does not depend upon the $\dot{\theta}$'s; then the conditions of steady motion are, that $\mathfrak{K} + V$ should be stationary, and the steady motion will be stable provided this quantity is a minimum.

The preceding theorem also enables us to deduce by a very concise method all the results connected with the steady motion of a liquid ellipsoid, which is rotating about a principal axis under the influence of its own attraction. It also enables us to examine the stability of these different cases of steady motion, for disturbances which produce an ellipsoidal displacement.

A. B. Basset.

THE PASSAGE OF GRANITE ROCK INTO FERTILE SOIL.

Having for the last three or four years paid particular attention to the natural formation of soil, I venture to believe that a concise account, or rather summing up, of the results of my researches, and of the mass of my observations—in one typical direction—may be of interest to the readers of Nature. As indicated in the heading, the making of soil from granite is the only section of a very large subject which will be briefly considered in this paper.

The agents concerned with the turning of granite (or any other rock) into a fertile soil may be shortly classified as mechanical, chemical, and vital. The first-named produce the largest results in bulk, and the principal mechanical agent with which we have to deal is frost. The second and third classes of forces are extremely important, as it is by their actions that the raw material of plant-food is prepared, though unfortunately poisons also are brought into being through their activity. These last-named classes, however, likewise materially aid the action of frost (or, in tropical countries, of varying temperatures) in the mechanical separation of rocky matter. To render my descriptions as little confusing as possible I will endeavour, without regard to classification, order, or divisions, to trace the history of a granite soil as I have observed it in many localities in Scotland, from the practically unbroken rock into the condition in which it has been made by nature fit to bear the most luxuriant crops. But first of all I must remind my readers of two or three geological facts about granite. It is a holocrystalline (*i.e.* wholly crystalline) igneous rock, composed essentially of orthoclase, quartz, and mica. In its most typical condition the last-named mineral is always of the biotite or magnesia-mica species. Besides these essentials we always find (in Scotch granites at least) plagioclase, other species of mica than the essential, apatite as an endomorph, *i.e.* locked up in the mass of other minerals, and magnetite, and almost invariably, if not always, a little pyrites, and more or less hornblende, &c.

A rough mineralogical analysis of Kemnay granite taken from the lowest working of the well-known quarry in Aberdeenshire gave the following percentages:—

Orthoclase-felspar	42·00
Quartz...	22·00
Biotite-mica	20·00
Plagioclase-felspar	9·00
Hornblende	3·25
Muscovite-mica	2·00
Magnetite (and Ilmenite)	1·00
Pyrites	0·50
Apatite	0·25
Total...	100·00

The first change which comes over granite is the peroxidation of some of the iron always present in its mass. This sets in, and increases to the greatest extent, of course, where air and water can most readily enter. The surface of the rock becomes browned with the hydrated ferric oxide formed, and brown skins, of a deeper colour than the surface generally, coat the walls of the original rock joints. But in the mass of the rock, away from these primary fissures, there are areas which are more permeable than others from the surface, and through these, streaks of ferric oxide—anhydrous first, afterwards hydrated—are produced. Those lines of rust are the beginnings of a new set of joints, which have not yet been properly recognized in geological literature, and which I will here call weather joints to distinguish them from the primary joints of consolidation and rock movements. The first oxidation streaks of the coming weather fissures are invisible to the eye, but can be determined under the microscope. They gradually increase in width above as they extend their lines beneath, and they afford passages through which water can more readily percolate than in the surrounding fresher areas, and as a consequence planes along which frost can more powerfully act. By the constant multiplying of the weather joints, which are first marked out by oxidation as already indicated, and afterwards made definite and widened from the most exposed rock surface inwards by frost, one of the first steps in soil formation is accomplished. As those fissures are increased the uppermost portion of the rock is separated by them into distinct pieces, which latter are again in their turn broken up by the formation of weather joints in the same way as the original. The great bulk of a soil has been produced in this way.

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[1] I must confess that I do not like the phrase *speed co-ordinates*, introduced by Prof. J. J. Thomson, for it conveys absolutely no meaning to my mind. I have no sympathy with the attempts, which have occasionally been made, to introduce short words of Teutonic origin into scientific nomenclature, as the words in question appear to me to be singularly deficient in point.

While the oxidation of the iron, as I have observed, is very likely the first change to set in in every case, it is never left for any lengthened period to promote, by itself alone, the decomposition of the rock. Very soon the work of carbonation is seen to be progressing alongside of it, though at a considerably slower rate. The carbonic acid gas of moist air, dissolved in the penetrating water, attacks the felspars, the biotite, and the hornblende. The way in which it brings about the decomposition of these minerals is interesting. Certain molecules succumb much more easily to the action of the carbonic acid than others, and the result is that scattered points of weakness from the thorough decomposition of these are brought into being in different parts of the mineral, and those decomposed portions warp round about the other and fresher molecules, as shown in the annexed diagram, which has been constructed from what I have observed in decomposed felspars.

The clay of decomposed felspar has great plastic and warping power. I have observed only 15 per cent. of pure clay in a mass hold the 85 per cent. of other and different constituents together in a plastic union as if the whole had been pure clay. There are two or three other hitherto unknown facts connected with the natural decay of felspars which I have ascertained from my researches. I have noted two processes of decomposition—that which occurs when the carbonic acid is in excess or can obtain free access to the mineral, and that which takes place when either of the opposite conditions prevails. In the first case the felspar—supposing it to be *orthoclase*—has the molecules of its body which are affected completely broken up into clay, solid secondary or colloid silica, and carbonate of potash. In the second case, where for some reason a sufficient supply of carbonic acid cannot get within "chemical" distance of the felspar molecules, clay is produced as before—only more slowly—but the potash of the molecule is carried off in two sections, part as a carbonate, and part as a soluble silicate.[1] From the *plagioclase*-felspar the same conditions produce similar results, except that the soluble silica which would be produced here is of course in combination with sodium. I have found the soluble silica of soils *always* in the form either of silicate of potassium or sodium, and very frequently both of these occur mixed together.

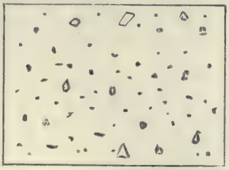

Diagram of kaolinized felspar × 260. The whole ground-mass is kaolin or pure clay; the bodies scattered through this are parts of the original felspar not yet decomposed.

Biotite, by the continued action of carbonic acid, oxygen, and water, loses magnesia (taken out as carbonate) and iron (removed either as oxide or carbonate) and becomes eventually the white or yellow muscovite variety which undergoes no further chemical change. In biotite, however, the chemical change usually takes place much more uniformly through the mineral body than ever happens in the case of the felspars.

Hornblende by carbonation, oxidation, and hydration yields lime as carbonate until the whole of that base is taken out, a trace of magnesia as carbonate (the bulk of this base is almost invariably left in the insoluble residue), the chief portion perhaps of its iron as oxide and carbonate, manganese as hydrated oxide, and any trace of sodium and potassium which it may contain as carbonates, or partially when conditions are less favourable as soluble silicates. The residue left after the hornblende has lost the above can generally be determined as some variety of chlorite (hydrated silicate of magnesia, iron, and alumina), which in the course of time by further loss of iron becomes an impure serpentine, and this later on a steatite or magnesia-clay, to which the greasy feel of soils is due.

The *pyrites* of the granite rock is slow to change, but it also is eventually acted on, by water and oxygen particularly, the latter combining with its substance here and there to form a sulphate, which has a great mission in the physiology of the soil.

I have said that the *apatite* occurs as an endomorph. It is set free to dissolve slowly without change in ordinary carbonated water when the minerals which hold its microscopic needles in their substance are broken up, mechanically or chemically. The *magnetite* and *ilmenite* grains of the granite rock are only altered with provoking slowness. Their function, however, in the work of the soil is, as far as I can see yet, of no importance. Traces at least of another mineral occur very frequently in granites. This is tourmaline, the history of which in soils I have been investigating for the last half-a-dozen years with some success.

The chemical changes which I have been mentioning begin first on the exposed surfaces of the rock and along the faces of the primary joints. Then oxidation occurs in streaks and bands through the rock mass, and around those areas carbonation is most active. In fact oxidation opens up the rock for further change, chemical as well as mechanical.

Frost is the principal agent of disintegration or mechanical breaking up in this country, but a relatively minute portion of the work is accomplished by heat and cold, the friction of percolating water, changes in the degree of humidity of the atmosphere, the pressure exerted by roots, and so on.

No sooner does a fraction of the surface percentage of the exposed rock portion undergo chemical change than a new element in the making of soil comes into play—that, namely, of organic matter, first living, and then dead and living. We will deal first with the living matter. On the partially decomposed surface of rock, fungal and algal spores (the latter of a lowly type) settle and live and grow in symbiotic union as lichens. There are many different kinds of rock-lichens, but the vegetative physiology of all is identical. The surface of the growth which lies next the stone is engaged in parts, during moist weather at least, in the imbibition of water, with the exceedingly meagre amounts of mineral matters dissolved in it from the surface of the rock. Those absorbing areas of the under surface appear to be also superficial breathing organs, for they certainly excrete carbonic acid gas, which of course will join with the atmospheric carbonic acid in helping the work of decomposition of mineral bodies. And it appears to me—though here I am not certain—that these absorbing areas are less generally found over the quartz of the granite, which is not capable of chemical change, than over the decomposable minerals. The lower absorbing areas of the lichens are in their functional relations common to internal fungal and algal members, and the upper surface of the colony is also a common absorbing (and transpiring) tissue, though here it is only the atmosphere gases which are taken in to the interior. There is not the slightest doubt but that the fungal members utilize the nitrogen of the air; there is none in the rock for them to receive; and that the algal members absorb carbonic acid gas from the air taken in, and combine it with the elements of water to make carbonaceous food, for that again is not presented to them from the rock; the lichen growth cannot any more than is the case with higher plants utilize the carbon of the mineral carbonates in the manufacture of carbohydrate or hydrocarbon food.

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[1] See also in this connection my article on "The Action of Lime on Clay Soils," NATURE, Jan. 29, 1890.

In reproduction, separate spores of algæ and fungi are produced from the lichen, and some of these may germinate above the parent community and unite to form a fresh colony upon the old, or a new colony may be produced from foreign spores. In any case we find generation after generation of lichens forming on the same favourable spot; but succeeding generations are partially parasitic and saprophytic in nature, as is shown by the manner in which their lower absorbing surfaces or prolongations act on the lichen growths beneath them. By and by, when perhaps a score of lichen colonies have formed one above the other—the newer slowly extinguishing the life of the older—a vegetable considerably higher in the scale of being comes forward and caps the last lichen. This is some variety of moss. Spores of mosses, carried to the stone surface, germinate there in moisture, and if upon lichens, the moss plantlet develops into the adult. Its rhizoïds pierce their way through the substance of the lichens, and many get down to the decomposing stone surface, while some never leave the lichen bodies. The action of the moss rhizoids on living and dead lichens, also, I think, shows that that plant can be a parasite and a saprophyte as well as a normal vegetable feeder; and in this respect, except in its not utilizing the nitrogen of the air, resembles the later lichen growths.

In this way, by the succession of lichens and mosses (and afterwards higher plants), the essential organic element of soils becomes early incorporated with the mechanically and chemically disorganizing rock.

The dead organic matter changes in different ways: first, very slowly and very indifferently, by the action of air and water; and second, rapidly, by the spreading through its mass, where air has free access, of bacteria and other lowly fungi which are saprophytic, but can also assimilate nitrogen from the atmosphere, as is shown by their increasing, and not simply maintaining the original amounts of nitrogen left by their predecessors. By the first method of change the organic matter becomes the tougher former of humus, and humic and other related acids arise from it; by the second the mild, dry, or friable humus is produced and little or no humic acid. A very careful investigation shows that those bacteria which have the power of removing from the dead organic matter the elements of their nutrition give out by the decay (which occurs rapidly) of their bodies when they die the nitrogen and other elements in an active state. The nitrogen of the dead bacteria forms readily nitrate of lime or potash by contact with these bases.

Now to give a short summary here. Oxidation of iron is the first change perceivable in granite; then creation and multiplication of weather joints, and carbonation follows; next humus is formed by lichens, and then higher plants; following this, fungoid germs, capable of assimilating aerial nitrogen, become abundant; finally all the three processes, mechanical, chemical, and organic, go merrily on together and contribute all in their proper shares to the formation of an ever-deepening soil, capable of supporting the luxuriant life of the highest plants. The humic acid which is formed by the inorganic decay of humus has a certain decomposing action, but it gradually changes to carbonic acid, with the action of which, in this connection, we have already dealt. Well, to apportion the shares of the work done further. By disintegration, or mechanical action, the great rough mass of the soil is produced. By oxidation and carbonation, soluble minerals capable of entering the plant are prepared, and insoluble matters like secondary silica, pure clay, and steatite, are brought into being. By the action of living matter, rock decomposition is hastened, and nitrogenous substance is brought into the soil. By the presence and action of dead organic matter, rock decomposition is also forwarded, and a field for aerial nitrogen-assimilating germs is prepared. The table below gives a list of the materials found in the youngest granite soil on which nothing higher than rock-mosses are growing.

Granite minerals in fairly fresh condition	About 80 per cent.
Clay and insoluble secondary silica ...	About 3 per cent.
Soluble silica	Not determinable.
Carbonates of potash, soda, lime, magnesia, iron, and phosphate of lime	About 2 per cent.
Sulphates of above, except iron	Not determinable.
Sulphate of iron	Merest trace.
Peroxides of iron and manganese ...	About 3 per cent.
Humus	12 per cent.
Total	100 per cent.

Later on, as the soil deepens, we find some curious changes proceeding, which I will briefly indicate. Sulphates are now produced in considerable quantities. Wherever iron-containing minerals are brought into contact with organic matter, sulphate of iron tends to form as well as carbonate (humate ?), and possibly other compounds; and the pyrites which was slow to change at the beginning now produces sulphate of iron with greater rapidity. The dissolved sulphate of iron coming into contact with the carbonates of the alkalies and alkaline earths liberated from the felspars, hornblende, &c., as already explained, causes a double decomposition. The ferrous sulphate becomes a carbonate, and the carbonates of lime, potash, soda, &c., become sulphates. The iron carbonate, where exposed to air, readily oxidizes to ferric oxide, the chief colouring ingredient of the soil.

Now, in the finished soil, which, it must be remembered, is when produced from granite a loam, we have the following approximate composition, as fairly typical of a good granite soil such as may be found in the valley of the Don in Aberdeenshire:—

			Per cent.
Insolubles	Pure clay and steatite	about	10
	Quartz and secondary silica ...	,,	20
	Muscovite	,,	4
Substances capable of transformation	Orthoclase...	,,	30
	Plagioclase	,,	4
	Biotite	,,	9
	Magnetite?	,,	0·5
	Hornblende	,,	2
	Hematite and limonite (ferric oxides) and manganic oxide	,,	9
	Pyrites	,,	0·5
	Humus and animal organic matter, fungi, &c....	,,	5
Injurious solubles	Humic acid	,,	0·5
	Soluble silicate	,,	0·3
	Ferrous sulphate[1]	,,	0·5
Non-injurious solubles	Phosphates of lime, magnesia, potash, soda, &c.	,,	0·3
	Sulphates of lime, potash, soda, magnesia, &c.	,,	0·8
	Nitrates of lime, potash, soda, magnesia, &c.	,,	0·3
	Carbonates of lime, potash, soda, magnesia, &c.	,,	0·1
	Chlorides of above	,,	Trace.
Water and air (mechanically held) in dry summer perhaps about		,,	3·2
	Total		100·0

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[1] More than 0·1 per cent. is injurious.

In conclusion I have to point out, as shown by my investigations commenced four years ago, that farmyard manure laid on to the land is only rendered properly available to the crops by the action of bacteria as indicated above in connection with the natural humus. The inorganic forces have little action upon it, except in producing humic acid and other injurious matters.

The most of the soluble mineral substances in a mature soil, it may also be mentioned, are in the form of sulphate. They originate from the primary minerals as carbonate, but are soon altered, mainly by the ferrous sulphate. The sulphate unfortunately is not the most suitable form in which minerals can be presented to plants for absorption, for the simple reason that, being so stable in chemical union, it causes the loss of too much of the plant's energy in the interior of its body before it can be decomposed. It must be remembered that green plants decompose the compounds which enter their system before they utilize their elements or simpler forms in the elaboration of food. ALEXANDER JOHNSTONE.

Edinburgh, August 5.

THE IMPERIAL INSTITUTE AT ST. PETERSBURG.[1]

IN November, 1885, some months after the publication of Pasteur's discovery for the treatment of hydrophobia, an officer of the Russian Guards was bitten by a rabid dog. This officer having been sent to Paris to undergo the treatment, his Highness Prince Alexander Petrowitch d'Oldenburg established, at his own expense, a provincial laboratory at St. Petersburg, where Pasteur's treatment could be duly carried out. This establishment, however, soon proved to be too small for scientific investigations to be properly carried out therein, and it was decided to build a large laboratory in which researches might be made under the best possible conditions; accordingly the same enlightened nobleman bought a piece of ground of 37,464 square metres in extent, on which the present Institute is built.

The buildings comprise physiological, pathological, chemical, bacteriological, and epizootological sections, with their laboratories, under the direction of such men as Neucki, Winogradsky, and others. There is also a department where Pasteur's treatment is carried out, together with a small hospital for infectious cases. Each section is complete in itself, and all the arrangements are on the newest principles and on a very large scale. The expenses are defrayed partly by the Prince of Oldenburg and partly by public subscription, and the whole Institute compares favourably with any Institute in France or Germany.

The directors of the Institute publish every two or three months a volume embodying the scientific results obtained in the laboratories, and the first two numbers have now been published. As might be expected after what has just been said, their contents are of wide and varied interest. Neucki publishes some chemical researches on the microbe producing inflammation of the mammary glands of milch cows and goats, and his paper will specially interest those who in this country have followed the remarkable researches of Dr. E. Klein. Winogradsky gives an account of the various nitrifying organisms discovered by him in the soil of different countries. This author quotes the researches of Prof. and Mrs. Frankland, and of Prof. Warington, and though to some extent contradictory, Winogradsky's researches agree with those of the English observers in all essential particulars. This paper is certainly the most important which has as yet appeared on this vexed question. The results obtained by Pasteur's treatment in St. Petersburg form the subject of a paper by Kraïouchkine, and it may be mentioned that the treatment appears to have been as successful at St. Petersburg as in Paris.

The other papers refer to the chemical and physiological effects of tuberculin (Bujwid, Helman), to the transformation of nutritive media by the bacillus of diphtheria, and to the chemical composition of this micro-organism (Dzierzgowski and Rekowski), while Blachstein endeavours to draw a distinction between the bacillus coli communis and the bacillus typhi abdominalis, based on the chemical decompositions produced by these organisms in the media in which they grow. Lastly, Mizerski and L. Neucki give a critical *résumé* of the methods used to estimate the quantity of hydrochloric acid contained in gastric juice.

The researches which form the subjects of these papers are varied enough, and whilst congratulating their authors we may express the hope that the Institute will have a long and prosperous career. Our good wishes must be tinged with regret for ourselves—regret that there should not be a similar Institute in England, and regret also that there should be in this country a class of people who will oppose the establishment of such an Institute until a Bishop or Royal Duke has died of rabies.

M. ARMAND RUFFER.

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[1] "Archives de Sciences Biologiques publiées par l'Institut Impérial de Médecine Expérimentale à St. Pétersbourg," Vol. 1, No. 1 et 2.

NOTES.

LAST week much anxiety was felt as to the health of Sir Richard Owen. On Monday his condition was better, and the improvement, was maintained on Tuesday.

THE herbarium of the British Museum has acquired, by presentation from the widow, the very valuable collection of Muscineæ, made by the late Mr. George Davies, of Brighton. It comprises upwards of 20,000 specimens of mosses, hepaticæ, and lichens, partly gathered by Mr. Davies in Great Britain and on the Continent, partly communicated to him from New Zealand, Samoa, India, the West Indies, and America.

PROF. HIERONYMUS has been appointed curator of the Royal Botanical Museum at Berlin.

THE Exhibition of the Photographic Society of Great Britain was opened on Monday at the Gallery of the Royal Society of Painters in Water colours. It will remain open till November 10.

WE regret to have to record the death of Mr. George Croom Robertson. He was fifty years of age, and only lately, in consequence of ill-health, resigned the professorship of Mind and Logic at University College, London, to which he was appointed in 1866. Prof. Robertson was well known as a brilliant teacher of the subjects to the study of which he devoted his life, and as the editor of *Mind*. He was associated with Prof. Bain in the editing of Grote's "Aristotle," and was the author of the volume on Hobbes in Blackwood's series of "Philosophical Classics." He also contributed to the latest edition of the "Encyclopædia Britannica."

DR. GEORGE DIXON LONGSTAFF died at Wandsworth on Friday last in his ninety-fourth year. When a young man he was assistant to Dr. Hope, Professor of Chemistry at the University of Edinburgh, and he is believed to have been the first teacher of practical chemistry to medical students in this country. He was one of the founders and a vice-president of the Chemical Society of London.

Students of folklore will be sorry to hear of the death of Reinhold Köhler, librarian at Weimar, where he was born in 1830. He died on August 15. Dr. Köhler was a man of great learning, well known as an authority on the subject in which he was chiefly interested.

THE American Academy of Arts and Sciences has published an excellent "Memorial" of Joseph Lovering, who was a Fellow of the Academy from 1839 to 1892, Corresponding Secretary from 1869 to 1873, Vice-President from 1873 to 1880, and President from 1880 to 1892. Mr. Lovering was born on December 25, 1813, and died on January 18, 1892. The "Memorial" consists chiefly of speeches delivered, and letters read, at a meeting held for the commemoration of his life and services, with a biographical sketch by Prof. J. P. Cooke, Secretary of the Council, and a list of Prof. Lovering's publications. At this meeting the chair was taken by Dr. A. P. Peabody, who said that there was a certain fitness in his leading the proceedings, as Mr. Lovering had been his pupil. Speaking of Prof. Lovering as a teacher of physical science, Prof. J. P. Cooke said: "He was one of the best lecturers I have ever known, and I have known the greatest masters of my time."

DURING the past week the weather has been of a decidedly cyclonic type; large disturbances have reached us with considerable frequency from the Atlantic, and have mostly passed to the northward of Scotland. The winds have been moderate to strong from the south-west, but have at times attained the force of a gale at places in the north and west, while on Tuesday they were boisterous in all parts of the United Kingdom. The rainfall has been somewhat heavy in the north and west, but light in the southern parts of the kingdom, where, during the first part of the period, the weather was generally fine, with occasional mist or fog in the mornings. The temperature has, on the whole, been mild, the day readings ranging from 60° to 65° over most parts, while in the extreme south they have exceeded 70° on several occasions. The *Weekly Weather Report* published on the 24th instant shows that some of the night minimum temperatures during that week were very low for the time of year, the shade thermometer falling to 25° in the east of Scotland, and to between 28° and 31° in most other parts.

AMONG the valuable discussions which appear in the *Repertorium für Meteorologie*, issued under the authority of the St. Petersburg Academy of Sciences, is one in vol. xiv., by B. von Nasackin, on the Storms of the Baltic, being in fact a continuation of similar works (by other authors) for the Black and White Seas. The data used in the discussion are taken chiefly from lightkeepers' journals and stations on the coast. The general results show that the yearly frequency of storms differs considerably in different years, and the number of storms at individual stations also varies considerably. In the western part of the Gulf of Finland and in the south of the Baltic storms are much more frequent than in the other parts. The mean wind-direction lies between south and west, and the principal storms occur from the same direction, and also between west and north. The maximum number occurs almost everywhere in December, and the minimum in August.

Das Wetter for August contains an article by Dr. R. Assmann on the treatment of persons apparently killed by lightning. The different effects on persons struck would prove that the intensity of the flash is subject to considerable fluctuations, and recent photographs of lightning, in fact, show that in addition to the principal flash there are always weaker ones branching out in all directions, like the roots of a tree. It may therefore well be assumed that the intensity of the latter is considerably less than that of the principal current. He quotes a case near Berlin in the summer of 1891 where a number of soldiers were struck by lightning; among them an officer, and a bugler holding his horse, were both struck. The officer shortly afterwards recovered, while the bugler was to all appearances dead, but the officer at once adopted the method of artificial respiration as applied to the apparently drowned, by which means the bugler was gradually brought back to life. Dr. Assmann states that there can be little doubt that if this method were applied soon after the stroke, and continued for at least a quarter of an hour, many of those apparently killed might be restored to life.

A VALUABLE paper by Prof. E. W. Hilgard, on the relations of soil to climate, has been published by the U.S. Department of Agriculture. Soils being the residual product of the action of meteorological agencies upon rocks, it is obvious, as Prof. Hilgard says, that there must exist a more or less intimate relation between the soils of a region and the climatic conditions that prevail, or have prevailed, therein. Prof. Hilgard discusses, both from a theoretical and from a practical point of view, some of the more important phenomena dependent on this correlation, and their effects on the agricultural peculiarities of the chief climatic subdivisions.

HERR K. FLEGEL gives, in the *Allgemeine Zeitung* for September 12, an interesting account of archæological discoveries he has made this summer in the island of Kalymnos, near the coast of Asia Minor. At a height of about 220 metres, not far from Emporió, he found the remains of an ancient fortress which seems to belong to the same class of buildings as those of Mycenæ and Tiryns. The remains, which are comparatively well preserved, include Cyclopean walls and a tower. A gateway (1½ metre in breadth), the forecourt, a cistern, and a stone oil-press survive. In the valley of Vathy, Herr Flegel came upon the remains of walls of an acropolis, which he describes as older than the fortress of Emporió.

IN the new instalment of the proceedings of the Liverpool Geological Society (Part 4, Vol. VI.), Mr. J. J. Fitzpatrick has some interesting notes on the Deep Dale Bone Cave near Buxton. In a paper read before the society in 1890, Mr. Fitzpatrick called attention to this cave, and described the various objects of interest which had been found in it up to that time. In his present paper he gives an account of the results of more recent researches carried on by Mr. W. Millet, of Buxton, by whom the cave was discovered. At the entrance is a refuse heap, three feet thick at the top, extending ten feet on either side of the entrance, and sixty feet down to the stream at the bottom of the dale. Among the objects found in this refuse heap are bones of the horse, stag, Celtic shorthorn (*Bos longifrons*), dog, pig, sheep, goat, wild boar, three flint flakes, a piece of bronze with Celtic pattern, fragments of pottery, including Samian ware, pseudo-Samian ware, Romano-British ware, coins of the Emperor Claudius, and female ornaments, including fibulæ, earrings, brooches, and rings. At the bottom of the heap were found two flint arrow-heads. In the second chamber of the cave a hole, eight feet deep, has been dug. The upper bed, three feet thick, is composed of dark clay, with angular fragments of limestone. The second bed, which is from six to sixteen inches thick, consists of broken fragments of stalagmite, limestone, and gravel. In this a human jawbone has been found. The third bed, the thickness of which has not been ascertained, consists of a stiff yellow clay, containing large pebbles, two of which have been artificially pointed at one end. The human jawbone has twelve teeth, with the enamel and dentine in an admirable state of preservation. There were originally fourteen teeth, the two "wisdom teeth" not having been developed at the time of the death of the person to whom the jawbone belonged. The mark of the weapon which gave what was perhaps the death wound is distinctly visible. The weapon penetrated deeply into the bone in a slanting direction, with an upward inclination, and the blow must have been struck from behind. Another object found in the second chamber is a small bronze box, filled with grey ashes, supposed to be the ashes of a cremated person. The lid is moulded with the raised zigzag pattern common in Roman ornamentation, the hollow parts being let in with red and green enamel. In the lower chambers, as stated in Mr. Fitzpatrick's former paper, the following mammalian remains have been found:—A skull of the brown bear (*Ursus arctos*), a skull of the Celtic shorthorn (*Bos longifrons*), teeth of the reindeer (*Cervus tarandus*), and of the red deer (*Cervus elaphus*), part of the skull of the wild boar (*Sus scrofa*), and some human bones.

THE July number of the *Korean Repository* opens with an article by the Rev. Dr. Edkins on the Persians in the Far East. He shows from native sources that at a very early period the influence of Persian ideas penetrated into China. The wide acceptance of these ideas was due in part to the doctrine of a future life, but Dr. Edkins attributes even more importance to the worship of the god of fire as the special ruler of the hearth and the god to be worshipped by newly married people. This, he says, is so adapted to the natives of Eastern countries with their strong family instincts, that it has easily kept its place and still has a firm hold on the popular mind. In another article a writer who signs himself "Viator" indulges in much enthusiastic admiration of Korea and the Koreans. He is especially emphatic in his praises of the scenery around Seoul, with its "grand amphitheatre of granite hills." "The city wall," he says, "climbing over the most precipitous ridges, the sentinel peaks of Nam San, with its chevelure of fine trees, and the bold castellated rocks of Poukan, which on the south and north respectively keep guard over the capital, with many other points both within and without the walls commanding varied and extensive views, would alone in any tourist-frequented land make Seoul a show-place of the guide-books." The ordinary Korean he describes as "a docile and happy creature."

WE learn from *La Nature* that MM. Olivet, of Geneva, have brought out a new system of electric heating applied to conservatories, which may prove very useful where a motor force is at one's disposal. A dynamo, worked by some motor, sends the current into receivers of special metallic composition, which become rapidly heated, but without exceeding a certain temperature. A heated air current is set up as with steam-heating. The advantages of the system are: Absence of all unwholesome gas or vapour which might injure the plants, simplicity of construction in the parts conveying the energy, perfect safety as regards heat, which can be regulated at will, convenience and rapidity in starting and extinction, and cleanliness.

MR. A. C. MACDONALD, of the Agricultural Department of Cape Colony, refers with much regret (in the official publication of the Department) to the senseless way in which the ant-bear is being exterminated. This animal, he says, is one of the few indigenous four-footed friends of the Cape farmer. "Its food is the ant, more especially the white ant, an insect which feeds on our crops and the succulent herbage of the veld, and which does much greater damage than is generally supposed. Although the ant has numerous enemies (among which is reckoned the koran, a bird which I am happy to say is now being preserved on some farms solely for this purpose), yet none are so destructive to its welfare as the ant-bear. It is only when on the surface of the ground that the ant runs any danger from its winged foes, but above or below ground it is always within reach of the ant-bear. But it is not only as a destroyer of ants that the ant-bear is of value to the farmer. A large percentage of the seeds of our herbage, after they have dropped off the plant on the hard ground, lose their germinating power from being exposed day after day to the scorching rays of the sun. The ant-bear, as it goes scratching about for ants, covers a large number of seeds with loose earth, in which congenial bed they will retain their reproductive power for a long period, awaiting the moisture from the skies to shoot out and propagate their kind. And yet this animal, harmless in other respects, is being slowly but surely exterminated. For its skin, which is valued at about 15s., and also for its flesh, which resembles superior pork, it is sought after by the natives. With the white race 'sport' is the inducement, this fun taking the form at times of forcing the poor brutes out of their holes by flooding with water, or drowning them and digging them out afterwards."

PROF. G. C. CALDWELL, of Cornell University, has been making oleomargarin a subject of careful investigation, and presents the results of his researches in a valuable paper in the September number of the Journal of the Franklin Institute. He thinks that if made of unsuitable materials oleomargarin may contain germs of disease, and that the process of manufacture ought to be carefully inspected by capable officials; but there is no positive proof, he says, that it is now, or ever has been, made of such materials, or that any disease has ever been communicated to man by its use. He is also of opinion that, when properly made from fresh and clean materials, it differs but slightly in healthfulness from butter. He records, however, a rather significant incident which has recently come to his knowledge. At an asylum for blind children, in Louisville, Ky., where good butter had been supplied, good oleomargarin butter was substituted. No notice was given of the change, and even if the appearance of the substitute would have betrayed it, the blind children could not have seen it. There was no evidence that they were in any way conscious of the change; but it was observed that they gradually ate less and less of the new butter and finally they declined it altogether. No bad effect on their health could be discerned. They made no complaint in answer to the inquiry as to the reason for not eating the butter other than that they did not care for it. It was as if it did not adapt itself to any need of the system. "This," says Prof. Caldwell, "certainly must be allowed to count against the complete fitness of oleomargarin as a substitute for butter."

A FIELD NATURALISTS' CLUB was formed last year in Trinidad, and seems likely to do much useful work. It publishes a journal, and in the third number, which we have received, gives reports of its meetings from the beginning. In the meeting on January 8 Mr. Mole announced that he had found a *Peripatus Edwardsii* in the St. Ann's Valley; and Mr. Urich stated that he also had found a specimen of the same species at Azouca.

THE report of the Government Central Museum, Madras, for 1891-92, has been published. In an interesting appendix Mr. H. Warth, the officiating superintendent, gives an account, among other subjects, of the tin district in Burma. The tin-bearing deposits are, he says, of two kinds. First, there is the tin gravel which is found in all or most of the valleys, a mixture of rough white quartz pebbles with sand, garnet, black tourmaline, and grey cassiterite. The thickness of the gravel varies from 1 to 6 feet, and the yield of cassiterite may be put down as at least $\frac{1}{4}$ per cent. or 1 pound of cassiterite (tin dioxide) in 400 pounds of gravel. There are washings going on at many places, but some valleys have been more or less exhausted. The work suffers also under the disadvantage that the greater part of the country is quite uninhabited, that food has to be brought from a distance, and that there is always danger of sickness. Chinamen are the chief workers. The second kind of tin-bearing deposit is the original eruptive rock, which is weathered so that it is possible to wash out the grains of whitish cassiterite which it contains. Mr. Warth visited the principal deposits of this kind near Malewun in July 1891. He took samples from several excavations and washed them. The mean is a yield of only 0·04 per cent. of impure wash tin.

Thus one pound of impure tin dioxide requires 2500 pounds of weathered rock. The rock is traversed by a series of parallel veins of white quartz indicating the origin of all the white quartz pebbles in the tin-bearing gravels, these gravels being nothing but the accumulation, during probably thousands of years, of the washings from the elevated outcrops of tin-bearing eruptive rock. The original tin-bearing deposit of weathered rock has been washed during a good many years. It requires a very good supply of water and very large deposits, otherwise the labour would be far too great and such works could not compete with those in the gravels. Among the rock specimens of the district are also grey limestones from Mount Tampra, three days' canoe journey from Lenya. This mountain Mr. Warth found fringed with caves which most likely owe their origin to the action of the sea. As they are now 160 feet above the sea, it appears that the land has been raised that much in comparatively recent time. If so, then the time during which most of the tin gravels formed was also comparatively limited.

THE third part of the tenth annual report of the Board of Fishery for Scotland has just been issued. It deals with the scientific investigations carried on during 1891. First there is a general statement of the results achieved; then comes a series of general reports; and these are followed by papers recording biological investigations. Finally, Dr. T. Wemyss Fulton gives an account of contemporary scientific fishery investigations in this and other countries. The following are the papers dealing with biological investigations: On the food of fishes, by W. R. Smith; observations on the reproduction, maturity, and sexual relations of the food fishes, by Dr. T. W. Fulton; additions to the fauna of the Firth of Forth, part iv., by Thomas Scott; contributions to the life-histories and development of the food and other fishes, by Prof. McIntosh, F.R.S.; on two large tumours in a haddock and a cod, by Prof. Prince and Dr. J. L. Steven. We may note that the volume is enriched with many admirable plates.

MESSRS. R. FRIEDLÄNDER AND SON, Berlin, have just issued the sixth annual report (for 1890) of the ornithological stations of observation in the kingdom of Saxony. The report has been prepared by A. B. Meyer and F. Helm, who have evidently spared no pains to make their work thorough and accurate. In an appendix observations relating to other animals in Saxony, besides birds, are recorded. There is also a list of the birds which up to the present time have been observed in that country, with notes as to their geographical distribution elsewhere.

THE Clarendon Press has reprinted Mr. J. G. Baker's "Summary of New Ferns discovered or described since 1874."

A WORK on "The Great Barrier Reef of Australia, its Products and Potentialities," by Mr. W. Saville-Kent, is to be issued by Messrs. W. H. Allen and Co. The barrier reef of Australia, represented by a vast rampart of coral origin, extends for no less than twelve hundred miles from Torres Straits to Lady Elliot Island on the Queensland coast. Between its outer border and the adjacent mainland it encloses a tranquil ocean highway for vessels of the heaviest draught. To the naturalist, and especially to the marine biologist, the entire barrier is described as "a perfect Eldorado, its prolific waters teeming with animal organisms of myriad forms and hues, representative of every marine zoological group." The author's object will be to render an account, in clear and popular language, both from a commercial and from a biological standpoint, of the most attractive subjects connected with the barrier region. There will be sixteen plates in chromo-lithograph, with grouped illustrations produced from original water-colour drawings by the author, and forty-eight plates in photomezzotype from original negatives.

THE New Zealand Institute has published its Transactions and Proceedings during 1891 (vol. xxiv., seventh of new series). The volume is edited by Sir James Hector, and contains many papers of considerable interest and value. The papers presented in the Transactions are grouped under the headings of Zoology, Geology, Botany, and Miscellaneous. The Proceedings include those of the Wellington Philosophical Society, the Auckland Institute, the Philosophical Institute of Canterbury, the Otago Institute, the Westland Institute, the Hawkes Bay Philosophical Institute, and the Nelson Philosophical Society.

THE *Journal of Botany* for September gives an account of the results of M. J. Bornmüller's botanical exploring expedition in Persia. The flora of the district visited is a very abundant one, but not many new forms were gathered. The mountain sides of Kuh Jupar, at a height of between 2900 and 3000 metres, were covered with dense forests of an undescribed species of *Ephedra*.

THE number of the *Oesterreichische Botanische Zeitschrift* for September is almost entirely devoted to the discussion of the question of botanical nomenclature, and the opinions on the various disputed points, of the leading English and Continental botanists.

MESSRS. CROSBY LOCKWOOD AND SON announce the following works:—"The Microscope: its Construction and Management," by Dr. Henri von Heurck, Director of the Antwerp Botanical Gardens, translated from the French by Mr. Wynne E. Baxter, F.R.M.S.; "Electric Ship-Lighting: a Practical Handbook for Electrical Engineers and others," by J. W. Urquhart; "Toothed Gearing: a Practical Handbook for Office and Workshop," by a Foreman Pattern Maker, author of "Pattern Making," &c.; "The Mechanics of Architecture: a Text-book for Students," by E. W. Tarn; "The Visible Universe: Chapters on the Origin and Construction of the Heavens," by J. E. Gore; "The Health Officers' Pocket Book: for Medical Officers of Health, Sanitary Inspectors, Members of Sanitary Authorities, &c.," by Edward F. Willoughby, M.D. (Lond.); "The Art and Science of Sail Making," by Samuel B. Sadler, practical sail maker; "The Complete Grazier and Farmers' and Cattle Breeders' Assistant: a Compendium of Husbandry, originally written by William Zouatt, thirteenth edition, entirely re-written, considerably enlarged, and brought up to the present requirements of Agricultural Practice," by William Fream, LL.D.; "Farm Live Stock of Great Britain," by Robert Wallace, professor of Agriculture and Rural Economy in the University of Edinburgh, third edition, thoroughly revised and considerably enlarged; "Tramways: their Construction and Working," by D. Kinnear Clark, M.Inst.C.E., new edition, thoroughly revised, in one volume; "The Wood-worker's Handy Book: a Practical Manual embracing information on the Tools, Materials, and Processes employed in Wood-working," by Paul N. Hasluck; "The Metal-worker's Handy Book: a Practical Manual embracing information on the Tools, Materials, and Processes employed in Metal-working," by Paul N. Hasluck; "Practical Lessons in Roof Carpentry," by Geo. Collings; "The Steam Engine: a Practical Manual for Draughtsmen, Designers, and Constructors, translated from the German of Herman Haeder, revised and adapted to English Practice," by H. H. P. Powles.

MESSRS. BELL AND SONS are about to publish the following books:—"The Student's Hand-book of Physical Geology," by A. J. Jukes-Browne, with numerous diagrams and illustrations, second edition, revised and much enlarged (Bohn's Scientific Library); "Sowerby's English Botany," Supplement by N. E. Brown, of the Royal Herbarium, Kew (to be completed in eight or nine parts); "Fungus Flora," a classified text-book of Mycology, by George Massee, author of "The Plant World," with numerous illustrations, 3 vols., vols. i. and ii.; "The Framework of Chemistry," Part 1, by W. M. Williams.

University College, Liverpool, has issued its prospectus of day classes in arts and science, and of the evening lectures, for the session 1892-93.

Part 48 of Cassell's *New Popular Educator*, with title-page and contents to vol. viii., has been issued. The next monthly part of the work will form the first part of a technical series of Cassell's *New Popular Educator*, published under the title of Cassell's *New Technical Educator*.

Messrs. Dulau and Co. have published a catalogue of works on electricity, galvanism, and magnetism—works which they offer for sale.

Four lectures on Cholera will be delivered by Dr. E. Symes Thompson in Gresham College on October 4, 5, 6, and 7, at six o'clock p.m. The lectures will be free to the public.

The additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Mrs. Trafford Rawson; a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, presented by Mr. A. de Turckheim; two Tigers (*Felis tigris* ♂ ♀) from India, presented by the Maha Rana of Oodeypore; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. Hugo Marshall; a Three-striped Paradoxure (*Paradoxurus trivirgatus*) from Java; presented by Mr. Douce; a Jackdaw (*Corvus monedula*), British, presented by Lt.-Col. R. F. Darvall, F.Z.S.; a Common Fox (*Canis vulpes*), British, presented by Mr. Lucius Fitzgerald; an Indian Cobra (*Naia tripudians*), an Indian Rat Snake (*Ptyas mucosa*) from India, presented by Mr. Arthur H. Cullingford, F.Z.S; a Common Boa (*Boa constrictor*) from St. Lucia, W.I., presented by H. E. Sir Walter F. Hely Hutchinson, K.C.M.G; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Miss Withers; two Tarantula Spiders (*Mygale*, sp. inc.) from Demerara, presented by Mr. H. Strong; a Black-headed Lemur (*Lemur brunneus* ♀) from Madagascar, a Duyker-Bok (*Cephalophus mergens* ♂) from South Africa, two Demoiselle Cranes (*Grus virgo*) from North Africa, four Emus (*Dromæus novæ-hollandiæ*) from Australia, deposited; an Indian Chevrotain (*Tragulus meminna*) from India, two Violet Tanagers (*Euphonia violacea*) from Brazil, a Shag (*Phalacrocorax gracilis*) British, purchased; three Wild Swine (*Sus scrofa*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

The Variation of Latitude at Pulkova.—*Astronomische Nachrichten*, No. 3112, contains two communications on the variation of the latitude at Pulkova, the first by Mr. B. Wanach, who discusses some old observations, and the second by Mr. S. Kostinsky, who has continued the former's recent observations made before July, 1891. During the years 1890 and 1891, Mr. Wanach obtained some very definite results with regard to this question by using the large Pulkova transit instrument in the Prime Vertical, and the object of the present discussion is to find out if any like result can be discovered. The observations used are those of W. Struve made between the years 1840-55, O. Struve 1858-9, Oom 1861-63, and Nyren 1879-82. If we employ those made in the years 1840-42 it is at once noticed that to satisfy the conditions a variation in the height of the pole of $\pm 0''{\cdot}1$ has to be assumed, while the maxima and minima occur at different months of the year, the latter on September, 1840, May, 1841, March, 1842, and the former on January, 1841, September, 1841, and October, 1842. The observations from 1843-63 present no direct fluctuations in the value of the mean pole height, but show that it remains constant or is proportional to the time during the whole period. Taking the values of the mean pole height for the years 1879-82, as obtained from a similar curve, it is found that a single sinus curve is not sufficient for the comparison; secondly, that the mean pole height is not the same as it was in 1841 and 1891, but is about $0''{\cdot}15$ greater; thirdly, that the chief maximum on March, 1881 coincides with the chief minimum on September, 1880, that is, exactly coincides with the phases of the pole height. It also happens that the series, which take more than two years, give only one distinct maximum and minimum (instead of two, as would be expected). Coming now to Mr. S. Kostinsky's work, whose observations were made by W. Struve's method with the aid of a large transit instrument by Repsold, the variation of latitude is clearly shown. With the aid of the curve, which accompanies the paper, the maximum of the latitude occurs on October 4, 1891. Owing to the observations not being quite complete, the epoch of minimum is uncertain, but the curve shows that it will take place somewhere before the end of the month of May 1892. Comparing this curve with that obtained by Mr. Wanach in the year 1891, we have for the dates of the greatest and least values of the latitude—

Max. in 1890, September 14. $\phi = 59^{\circ}\ 46'\ 18''{\cdot}39$
Min. ,, 1891, April 15 $17{\cdot}79$
Max. ,, 1891, October 4 $18{\cdot}44$
Min. ,, 1892, May 20–31 (about).

Double Star Observations.—The second part of Appendix I. to the *Washington Observations for* 1888 contains the observations of double stars made at the United States Naval Observatory during the period 1880–1891, by Prof. Asaph Hall. These observations have been made with the intention of carrying on the work that was begun with the same instrument in 1875. The stars here observed are mostly known binaries. Some are of special interest on account of their short periods, while again the motion of others will be found to be very slow. This volume will be welcomed by all double star observers, for in such a work as this a strict comparison of observations is needful in such measurements as are here dealt with. The form in which the observations are printed is the same as was the case in 1881. The star's name is first given, followed by its right ascension and declination, and its magnitude. In the first column the date of observation in years and decimals of a year is given, while in parallel columns the sidereal time of observation to the first decimal of an hour, position angle, distance, and weight of observation are similarly inserted; in two other columns the magnifying power employed and occasional notes are added for reference. The volume concludes with an index of all the stars observed. The numbers of the stars are for the most part those of the Struves; but Prof. Hall, in recording those faint stars in the Pleiades, has referred them to Bessel's list of fifty-three stars in this group. Bessel's stars themselves he has numbered in the order they appeared in the *Astronomische Untersuchungen*, first volume, p. 237.

Solar Observations at Rome.—In the August number of the *Memorie della Società degli Spettroscopisti Italiani*, Prof. Tacchini contributes, in tabulated form, the results of the solar observations made at the Royal Observatory during the second three months of this year. Considering first the faculæ, they seemed most numerous on the southern hemisphere, there being an excess of 13. Latitudes 20° to 10° north, and 20° to 30° south, were the zones of greatest frequency, the number recorded being 49 and 50 respectively. Taking the whole numbers for both hemispheres the table shows a distinct increase, the numbers for the three months being 71, 75, and 97. With reference to the spots, the two hemispheres seem to have been evenly distributed, the numbers seen amounting to 48 and 46 respectively. The zones of greatest frequency were found to be $\pm 10^{\circ} \pm 20^{\circ}$, the number of spots recorded being 29 and 22; but in zone $-20^{\circ} - 30^{\circ}$ as many as 19 were noted, the number in the corresponding zone of the northern hemisphere amounting only to eight. The record of eruptions for this period is not very high, six only being seen in the northern and three in the southern hemisphere; the zone of maximum frequency for the northern hemisphere is $+10^{\circ} + 20^{\circ}$, the same as that for spots, the six observations occurring in this zone alone; for the southern hemisphere the three eruptions were observed in each of the 10° zones included between -10° and -40°.

GEOGRAPHICAL NOTES.

As the result of recent explorations by Lieutenant Fromm in the southern part of German East Africa, it appears probable that the difficulties which beset navigation on the Rufiji and Rovuma rivers are not so serious as has hitherto been supposed. The resources of the country traversed by these rivers are reported to consist mainly of india-rubber in the forests. An examination of a coalfield reported by Arabs as existing on a tributary of the Rovuma showed that the valuable coal-seams were practically confined to the Portuguese side of the frontier.

IN a recent number of *Petermann's Mitteilungen*, Dr. Karl Grissinger publishes an interesting investigation of the physical conditions of the Weissensee in Carinthia. The paper is accompanied by a bathymetric chart, which shows that the lake belongs to the same class as the long, narrow, deep lakes of Scotland, and by a remarkable diagram of temperature changes. The latter is constructed so as to show the diurnal change of temperature at all depths from hour to hour for four consecutive days, and is in a high degree interesting and instructive. Diurnal change of temperature becomes imperceptible at a depth of 37 metres, and the hour of maximum temperature is retarded as the depth increases. Thus the surface maximum occurs about noon, while that at a depth of 25 metres is not attained until 8 a.m. of the following day.

A RECENT official estimate of the coast line of the United States, including islands, indentations, and estuaries, gave as the total 90,900 miles. Of this the Atlantic Ocean accounted for 36,500 miles, the Gulf of Mexico for 19,100, the Pacific Ocean for 8900, and Alaska for 26,400. Considering only the general coast lines, neglecting estuaries, bays, and islands, the Atlantic margin measured 2000 miles, the Gulf of Mexico and Pacific Ocean 1800 each, and Alaska 4800, a total of 10,400 miles.

M. J. GAULTIER has elaborated a system of photographic surveying, which is attracting considerable attention in France in view of the approaching revision of the cadastral survey of that country. By means of a specially mounted camera, a series of twelve views are taken from one point, so as to comprise the entire horizon. A set of signals, the position of which is carefully arranged, enable the various plates to be afterwards fitted together. The map is subsequently traced out on waxed linen by a sharp point, a faintly printed copy of the photograph serving as a basis.

THE uncertainty of communication with the Upper Nile valley makes it difficult to determine the precise weight to give to reports of events happening there. But it appears highly probable that an expedition from the Congo Free State has at last succeeded in establishing a station at Wadelai, or some other point within the British sphere of influence. The natural outlet of the region is of course down the Nile, and it is scarcely in accordance with the principles of geography that a prosperous development can ensue with so difficult an outlet as that to the Congo. The practical aspects of the case are in their present stage more political than physical, and in this stage they are likely to remain for some time.

ON Tuesday the *Times* printed the following telegram, dated September 26, from its Calcutta correspondent :—Mr. Conway's mountaineering party, which left Askoley on July 31, reached the foot of the Baltoro Glacier after four days' march, and proceeded up the glacier for four days. They then climbed a peak north of it 20,000 feet high, which they named Crystal Peak, and hoped to get a view of the great peak "K^2," but it was hidden by a neighbouring peak. They then went another day's march up the glacier and climbed a pass to the east of Crystal Peak 18,000 feet high. From this they saw "K^2," but discovered that the map was altogether wrong in the representation of the neighbourhood of that peak. They also found the Baltoro Glacier considerably longer than the map makes it. A high peak not marked on the map stands at the very head of the glacier. This Mr. Conway named the Golden Throne. They determined to try the ascent, and went one march further up the glacier and then were stopped by a snowstorm, during which they sent the coolies down to collect firewood. They reached the foot of the Golden Throne on August 18, and then worked up behind the peak, climbing over 2000 feet through a very broken icefall. It took four days to establish and victual a camp above the ice-fall, at a height of 18,000 feet. They moved next day to a camp 19,000 feet, and the day following to one about 20,000 feet high. Thence, on the 25th, they started for a real climb, and having reached a point over 23,000 feet high, they found they were on a mountain entirely cut off from the Golden Throne, which was still 2000 feet above them. The peak they ascended—which they named the Pioneer Peak—commanded a magnificent view, especially in the Hunza direction, where they could see to the distance of at least 200 miles. They suffered from the great altitude, but not severely, and they could have climbed at least a thousand feet higher, and perhaps more. They slept that night in their camp 20,000 feet above sea-level. They were obliged to descend next day as their provisions were exhausted. Bad weather commenced on the 27th, and continued, putting an end to climbing for the present season. Mr. Conway has gone to Leh, for the purpose of comparing his barometer with the standard there, and accurately reckoning the height of the Pioneer Peak. He expects that the comparison will show that they attained a height at least a thousand feet above Schlagintweit's 22,230 feet in Nepaul, which is the highest climb hitherto authentically recorded. He will then return to India.

THE IRON AND STEEL INSTITUTE.

THE autumn meeting of the Iron and Steel Institute was held last week in Liverpool, under the presidency of Sir Frederick Abel. The meeting was fairly successful on the whole, although the weather marred some of the excursions, and the last day's sitting was simply wasted time. The following is a list of the papers read :—"On the Manufacture of Iron in its Relations with Agriculture," by Sir Lowthian Bell ; "On an Apparatus for Autographically Recording the Temperature of Furnaces," by Prof. W. C. Roberts-Austen ; "On the Alloys of Iron and Chromium," by R. A. Hadfield (Sheffield) ; "On the Liverpool Overhead Railway," by J. H. Greathead ; "On the Engineering Laboratories in Liverpool," by Prof. H. S. Hele-Shaw ; "On the Failures in the Necks of Chilled Rolls," by Charles A. Winder (Sheffield) ; "On a New Process for the Elimination of Sulphur," by E. Saniter (Wigan) ; "On the Elimination of Sulphur from Iron," by J. E. Stead (Middlesborough). A paper on the basic Siemens process, by Mr. Kupelwieser, of Witkowitz, was also on the list, but was adjourned until the Spring Meeting of next year.

Upon the members assembling in St. George's Hall, on Tuesday, September 20, they were welcomed by the Mayor of Liverpool, and the reception formalities being disposed of, Sir Frederick Abel gave a short address, in the course of which he commented on the papers about to be read, and also stated that Mr. E. Windsor Richards, of Low Moor, had been elected by the Council to be President of the Institute, in succession to himself, during the coming two years during which the presidential term lasts.

The first paper on the list was Sir Lowthian Bell's contribution, which he read from MS., the paper not having been prepared in time to be printed. Those who are accustomed to attending meetings of this kind know how difficult it is to follow the reading of a paper even when they have the help of a printed copy, but when one has to depend upon one's hearing only, in a large room and amidst many disturbances, the task is hopeless. So far as we could gather, the author treated his subject *ab ovo*, and much of the first part of the paper might be found in various elementary text-books. The main point of interest was a description of an apparatus which has been devised for arresting and securing certain products which are to be extracted from the fumes of blast furnaces using raw coal. The chief of these by-products is sulphate of ammonia, and the author pointed out how necessary it was to the harmonic working of an economic system that this sulphate of ammonia should be collected and returned to the earth as a fertilizer. Of course, there is no gainsaying this part of the argument, and, as it is perfectly possible to collect the fumes and products of combustion, the question resolves itself into one of profit and loss. Sir Lowthian quoted figures which would, in these lean times, make the ironmaker's mouth water, and almost convert the iron itself into a by-product, but unfortunately, as it appeared afterwards during the discussion, the selling prices which the author had taken were by no means those of the present day. Mr. Snelus spoke of the remarkable fertilizing properties of sulphate of ammonia and nitrate of soda. He had spread one half of a newly-sown lawn with a mixture consisting of one part of sulphate of ammonia to three parts of nitrate of soda—four cwt. to the acre—and had grass an inch long, whilst the unspread part was quite bare.

The next paper taken was that of Prof. Roberts Austen, in which was described a modification of the Le Chatelier pyrometer, which has been introduced for the purpose of securing autographic records of temperature. The apparatus was exhibited at the council table, and has been constructed under the directions of the author for Mr. E. P. Martin, of Dowlais, in order that a continuous record might be kept of the temperature of the stoves in which the blast is heated for the iron smelting furnaces. It will, of course, be understood that the apparatus is suitable for recording temperatures under other conditions, and it can hardly fail to afford valuable assistance to those engaged in many branches of manufacturing industry, and in the scientific investigating of processes; in fact, in many branches of metallurgical inquiry, and also in the study of steam engine economy, there has been no want more widely felt in times past than that of a trustworthy means of ascertaining high temperatures. The author had previously described an apparatus he had before devised, and that shown was the result of a desire to simplify the design. The original apparatus consisted of a camera containing a reflecting galvanometer of the Depretz and D'Arsonval type of about 200 ohms resistance. A thermo-junction is connected with this galvanometer, and the amplitude of the deflection of a spot of light from the mirror affords the basis in calculating the temperature to which the thermo-junction has been raised. An autographic record of the temperature may then be readily obtained if the spot of light from the mirror falls into a sensitized photographic plate actuated by an astronomical clock, or by other suitable mechanism. Such an appliance as this, though well adapted for conducting investigations, is not sufficiently simple for industrial purposes, and the author determined that it was necessary to simplify the part which receives and records the spot of light; and also to arrange for attaching several thermo-junctions, so that there would be one for each furnace, and each might be brought in connection with the recording apparatus in turn. In order to effect these changes the original moving plate was replaced by a clockwork-revolved cylinder, to which was attached sensitized paper. In the apparatus shown provision was made for placing any one of six centres of heat, such as hot-blast stoves or furnaces, in connection with the galvanometer, and for obtaining within the period of the revolution of the cylinder a record of the temperature of any one, or of all the six sources of heat. The records will, of course, be intermittent, the duration of the test in any particular case being subject to the will of the operator; or the shifting of the electrical contact from furnace to furnace could be carried on by clockwork. The apparatus would then be entirely independent of manual adjustment.

In the discussion which followed the reading of the paper the most important point was that raised by Dr. W. Anderson, the Director-General of Ordnance Factories, who asked what was the durability of the thermo-couple, and whether the intensity of the current would alter owing to changes in the metals after exposure to high temperature. It will be remembered that the metals used are platinum and rhodium. Mr. T. Parker also asked if the couple was protected. Sir Lowthian Bell, who has had considerable experience with the Le Chatelier pyrometer in practical use at the Clarence Iron Works, said that in regard to durability and constancy of record, the device was most successful. He had only had to renew three or four couples, and they certainly would give accurate readings for the space of several weeks. He had proved this by comparing new and old couples, and also by testing at known temperatures. The author subsequently stated that the couples were put naked in the blast, and did not require protection unless subject to the impact of a shower of metal, in which case they were placed in a porcelain sheath.

Mr. Greathead next read his paper on the Liverpool Overhead Railway. This is a new railway which follows the "Line of Docks," and extends for a distance of about six miles. It is composed, for the whole distance, with the exception of a length of a few hundred feet, of an iron viaduct of uniform height, and which is continuous from end to end; unless some of the swing bridges on its course be open. The railway itself has been previously described, but the rolling stock has not, we believe, before been dealt with. Electricity will supply the motive power, there being a generating station situated about the middle of the line, where there will be four engines working up to 400 horse-power, each driving a separate Elwell Parker dynamo. The current will be carried along the line by a steel conductor placed on porcelain insulators. Hinged collectors of cast iron, sliding upon this conductor, will make the connection between the motors on the train and the generating dynamos. There will be no separate locomotives, the motors being on the cars, two cars forming a train to seat fifty-six passengers, the total weight being about forty tons. The signals will be worked by the trains themselves through an automatic device. The total cost of the railway is to be £85,000 per mile.

The second day, Wednesday, September 21, was opened by the reading of Mr. Hadfield's paper. This is a production of the kind that brings despair to the heart of those who prepare brief notices of these meetings. It consists, with the appendices, of over eighty-three pages, besides numerous sheets of tables, diagrams, &c. It begins with Vauquelin, and ends with a bibliography—*ab ovo usque ad mala*, as the author himself says; but the difficult part of the matter is that throughout the whole treatise there is not a part that could well be left out without disadvantage to the reader. Having said so much it will be evident that we can give but a very faint indication of the contents of Mr. Hadfield's paper. It is well known that he has made a special study of the alloys of iron and chromium, generally known as chrome-steel, and his success as a practical steel maker has been most marked. He has now put the results of long research and experiment at the disposal of all steel makers, and we cannot do better than refer those interested in the subject to the original work, which will duly appear in the volume of the proceedings of the Institute. It is noteworthy that chromium appears not to be in itself a hardener of steel, but that it acts indirectly by influencing the action of carbon upon the iron. Some of the photographic reproductions of chromium steel projectiles attached to the paper are very interesting, as showing what punishment this metal will stand. The shells go through nine inches of compound armour and eight feet of oak backing without apparent damage, the points being as sharply defined as in the shell as it comes from the shops. At a range of eighty yards two six-inch shells went through the thickness of armour mentioned, the striking velocity being 1825 feet per second, and the energy 2250 foot tons. One projectile altered ·01″ in diameter and the second ·013.″ One of these projectiles was fired through another 9″ plate without apparent damage. A 13·5″ projectile, also of Hadfield's make, was fired at a target consisting of two armour plates with 20″ of oak between. The first plate consisted of 18″ of compound armour backed by 6″ of wrought iron. Next came the 20″ of oak, and then a 10½-wrought iron, and finally a 2″ wrought-iron plate. This gave a total of 36½″ of steel and iron, besides the oak. The penetration was complete, but the illustration shows the projectile to have been broken into three parts. The striking velocity was 1950 feet per second, and the energy on impact 34,280 foot tons. The weapon was a 63-ton B.L. gun.

In the discussion which followed this paper—which the author read in abstract, having previously distributed printed copies—Prof. Roberts-Austen pointed out that the author's researches supported the views taken by himself and Osmond as to the dual form in which iron exists. This was shown by the diagrams showing the rate of cooling which accompanied the report. In these, when the cooling was from a high temperature, 1320° C., the curve was continuous throughout, but when the cooling was from about a thousand degrees, there was a point of recovery indicating recalescence. The diagrams formed part of a report by Mr. Osmond on Hadfield's chromium steel, which the author had incorporated in his paper. Prof. Roberts-Austen said he had arrived at the same results working independently. Another point worth recording is that remarked upon by Mr. Vickers, who dwelt upon the difficulty of deciding whether the effects noted in the steel were due to carbon or chromium, as it seemed impossible to separate the one from the other, the chromium invariably disappearing with the carbon. Mr. Vickers also started the old question of hardening by oil or water, a process which he advocates. Dr. Anderson put the matter in its true light by pointing out the danger from untrustworthiness due to the hardening process, defects being sometimes set up of which there was no outward indication. This, of course, refers to metal in large masses, such as gun-hoops, &c. Mr. F. W. Webb, the Mechanical Engineer to the London and North-Western Railway, gave high praise to chromium steel, saying he used it entirely for springs and also with advantage for tyres. He likewise found it an excellent material for tool steel.

Mr. Winder next read his paper on the failure of chilled rolls. The breakage of rolls is one of the most annoying of the many troubles with which the producer of manufactured iron has to contend. This is a matter which has hitherto received too little attention, it being generally considered to be in the nature of rolls to break, and nothing man could do would prevent it. It is as evident as like produces like, that if some rolls will last for considerable periods of time, others of exactly similar description, and working under the same conditions, would stand equally long. Sometimes four or five rolls—the author instances eleven in a fortnight—will give out one after another, until at last one will be found to accomplish the work. Mr. Winder, as a roll founder, endeavours to bring some sort of order into the process of manufacture. He points out that when a train of rolls is hard at work in the present day they will turn out as much as 1000 tons a week, and the passing of this great weight of red- and white-hot billets or blooms will be almost equal to putting the rolls into a furnace. The necks of the rolls are, however, kept cool by water, so that the lubricant may not be burnt off, and the sudden cooling thus caused produces a molecular change in the metal which, the author considers, accounts for much of the mischief. In order to overcome this difficulty it is recommended that there should not be too sudden a reduction of the diameter of the body of the roll where the neck is formed. That, in brief, appears to be the author's opinion, and doubtless his advice is good; in fact, it follows one of the cardinal laws observed by good iron-founders in the casting of other articles besides rolls. A good practical discussion followed the reading of the paper. We think that foundry practice is a little behind in this country, and in this respect we might, with advantage, take a hint or two from American methods, perhaps more especially in regard to smaller castings than chilled rolls, which often fail unaccountably in the United States also. The advice to roll founders to cast with a bigger head should not be, but apparently is, necessary. Prof. Turner's remarks were to the point, and it would be of advantage if he would make his researches in this direction more fully public.

Prof. H. S. Hele-Shaw was the author of the last paper read on the Wednesday of the meeting. The Walker Laboratories form part of University College, Liverpool, and are among the most recent and best arranged establishments of the kind. They have been erected under the guidance of the author of the paper, who occupied the chair of Engineering Science when the school was in a far less magnificent form. We have not space to follow the author in his description of the buildings, or the method of instruction. The latter appears to be framed in a manner calculated to turn out good engineers, a class which cannot be too large for the welfare of the country, although complaints are growing daily that they are already too numerous for their own advantage.

The last day of the meeting was Thursday, September 22, when two papers were read. The first was the contribution of Mr. Saniter, and in it he described the process by which he proposes to remove sulphur from iron by calcium chloride and lime. The experiments quoted go to prove that lime alone removes a considerable quantity of sulphur from iron if the contact is sufficiently prolonged; and, further, that a mixture of calcium chloride and lime completely eliminated the sulphur in the space of half-an-hour. Chloride of calcium is a by-product of the manufacture of ammonia, of soda (by the ammonia process), and of Weldon's bleaching process. The author states that the production amounts to many thousands of tons, of which only ten per cent. finds useful employment, the remainder running to waste. The subject is one of considerable importance, and no doubt the process will be freely criticized when it comes up again for discussion at the next spring meeting.

Mr. J. E. Stead's paper on the same subject—the elimination of sulphur from iron—was a much more imposing contribution, covering 40 pages of the proceedings. It dealt broadly with the whole question, and forms a most valuable contribution to the literature of the subject. At the conclusion of the reading of his paper Mr. Stead said that since it had been written he had had further light thrown on the matter by experiment and otherwise. He therefore proceeded to read from a MS. certain fresh matter, which appeared to occupy as much space as the paper itself. No doubt Mr. Stead will weld the original paper and the additions into one harmonious whole, which will then form a standard work of reference on a subject which has come to the fore so much within the last year or two. We congratulate Mr. Stead upon his courage in dealing with this matter in the way he has, and especially upon the practical disclaimer of infallibility which the appendix to his paper supplied.

There was no discussion of these papers, their consideration being adjourned until the spring meeting of next year. The matter should be well thrashed out, as speakers will have had an opportunity of consulting authorities, marshalling facts, or even making fresh experiments. It is to be hoped that in the future more discussions will be arranged on similar lines.

The proceedings closed with the usual votes of thanks to those in Liverpool to whom the Institute was so largely indebted for the success of the meeting.

There were several excursions during the week. The chief of these were to the Manchester Ship Canal, the Vyrnwy Water Works, the Lancashire and Yorkshire engineering shops at Horwich, the Liverpool Overhead Railway, and Laird's shipyard. A visit was also paid to the Walker engineering laboratories, where Prof. Hele-Shaw had collected some very interesting models for the occasion. The most striking of these was an exceedingly intelligent chain-making machine which has recently come over to this country from the United States. The whole of the operations are automatic, reels of wire going in at one end of the apparatus, and coming out one continuous length of chain at the other, and this without human intervention of any kind. The machine may, in the ingenuity of its design, rank with Laycock's horsehair loom, which we described in connection with the visit of the Institution of Mechanical Engineers to Sheffield of two years ago. It is really surprising to see what complicated operations mechanism may be made to perform by means of cams, levers, and springs. Mr. Laycock's loom exhibited perhaps a higher intelligence than the chain-making machine, inasmuch that it would select suitable hairs from a bundle, and would refuse to continue the work unless the proper kind were supplied. The chain-making machine, on the other hand, has to deal with a more stubborn material and has to connect each link. We do not know the name of the inventor of this machine, but the chain is known as "Triumph Chain."

FUELS AND THEIR USE.

AT the annual meeting of the Society of Chemical Industry, held in London on July 20, the chair was occupied by Dr. J. Emerson Reynolds, F.R.S. He chose, as the subject of his presidential address, "The modern developments in regard to fuels and their use"—a subject, as he explained, which had occupied much of his attention. The address was one of popular, as well as of scientific, interest.

After some preliminary remarks, Dr. Reynolds said:—

The fuel question is one which concerns those of us who live on the western side of St. George's Channel even more seriously than it does you, as our coal beds have been washed away in ages past, and of native fuel there is practically none save peat; hence industries which require large quantities of cheap coal cannot flourish in Ireland under existing conditions. It is, therefore, our interest to watch closely the development of improved and economical methods of using such fuel as we can obtain from other countries, and apply them in the utilization of our bulky but abundant peat. It is evident that no other fuels need be considered save coal, peat, and petroleum; hence, my remarks can take somewhat the form of a trilogy, minus the dramatic element, precedence being given to the solid fuels, and the first place necessarily to coal. . . .

The Royal Commission on Coal Supply, which commenced its sittings in July, 1866, and reported in July, 1871, after inquiring into all probable sources of coal in Great Britain, arrived at the conclusion that not more than 146,480 million tons were available at depths not exceeding 4000 feet from the surface. Therefore, at our present rate of increase of population and of coal consumption, our supply would not last for 230 years. But Mr. Hall, one of Her Majesty's Inspectors of Mines, who has special experience of coal mining, forms a much lower estimate of the supply practically available with our present means, and considers 170 years as the more probable duration of our coal beds. This estimate is based on fuller information than that possessed by the Royal Commissioners; we are therefore justified in concluding that the inhabitants of Great Britain 170 years hence will have little, if any, home-raised coal to burn if we continue to use it in our present wasteful fashion.

It was pointed out by the Royal Commissioners in 1871 that we cannot suppose 'the production of coal could continue in full operation until the last remnant was used, and then suddenly cease. In reality a period of scarcity and dearness would first be reached. This would diminish consumption and prolong duration; but only by checking the prosperity of the country.' . . . . 'Much of the coal included in the returns could never be worked except under conditions of scarcity and high prices. A time must even be anticipated when it will be more economical to import part of our coal than to raise the whole of it from our residual coal-beds.' As the area of coal-bearing strata in North America is fully seventy times greater than ours, it is easy to see where our future supplies must come from. The rate of increase in the use of coal has been greater than the Commissioners anticipated in 1871, and Mr. T. Foster Brown, C.E., President of Section F of the British Association at Cardiff last year, has placed on record his opinion that at the end of only fifty years from the present time the increased cost of coal will be severely felt. Pessimism is never pleasant; nevertheless we cannot afford to ignore reasonable inferences from fairly ascertained facts.

I apprehend that there are few ordinary consumers likely to be influenced in avoiding waste by the knowledge that we are within measurable distance of the end of our store of British coal, as that calamity may still be some generations off. But the case is very different with large consumers; the inevitable, if gradual, increase in the cost of coal has effectually arrested the attention of those directly concerned in our great industries or anxious for the maintenance of that manufacturing supremacy to which this country chiefly owes its wealth and power. Keen international competition in trade has quickened the effort to get the utmost work out of fuel, and therefore to diminish waste.

No such considerations have, however, produced any effect on the domestic conscience. A spasmodic increase in cost of coal stimulates the use of various economical devices which are almost wholly given up when prices fall back nearly to their former level. A small residual effect is left, which, though slight, is on the right side. But that economy in the domestic use of coal which could not be effected by a patriotic desire to avoid the too rapid exhaustion of our coal beds, or by a fear of permanently dear coal, is likely to be brought about by the growing nuisance of large towns, namely, fog, for whose increase our 'hearths and homes' are in a greater degree responsible than the much abused factory chimneys. The primary consideration in seeking to cope with the fog demon no doubt is to avoid the production of solid particles during the combustion of any fuel we may use, hence that method which avoids the formation of smoke at any time, and is both more convenient and economical, must ultimately 'hold the field.' As you well know, various suggestions have been made for the purpose of avoiding the production of smoke, and it has even been proposed that the use of non-flaming coal should be made compulsory in all large towns, notwithstanding the difficulties known to attend the combustion of anthracite or similar substances in open grates. But even if the fog demon could be satisfactorily exorcised by such means, the fact would remain that the combustion of any solid fuel in an open grate is a most wasteful proceeding. On the other hand, closed grates or stoves have not been popular in these countries. How, then, can we combine economy in the use of coal with smokeless combustion and domestic convenience? The answer is sufficiently obvious—we must more or less completely gasify the coal prior to its complete combustion.

The late Sir William Siemens showed us long ago how to convert coal completely into gas by means of his great 'producer' furnaces, and demonstrated the applicability of the comparatively poor 'producer' gas to operations requiring very high temperatures as well as to the minor work of steam raising. Siemens showed that when so used one ton of coal can perform as much work as 1·7 tons directly burned. In such comparisons the 'producer' gas was, of course, burned at a short distance from its source and under the regenerative system. This mode of using coal seems to be the most economical of which we have practical experience; but the gas which is produced seldom contains less than 65 per cent. of useless nitrogen, and therefore is not rich enough in combustible matter for general distribution.

The Wilson method of gasifying coal and that employed by the Leeds forge, permit the production of a richer gas. The Wilson process involves the formation of a certain proportion of 'producer' gas in raising the temperature of the coal up to the point at which it can decompose steam, and then affords a mixture of carbon monoxide and hydrogen, or so-called 'water-gas.' The former can be used for steam raising or furnace work in the immediate vicinity of the producer, while the water-gas can be transmitted through mains as readily as ordinary town gas, and loses nothing by carriage save its initial heat. Thus one general method affords two qualities of fuel and gasifies the coal in an economical manner.

Whether by the Siemens method in its modern form or by the more or less complete conversion into rich water-gas, a great saving in coal can now be secured in almost all large operations requiring the command of high temperatures; and the use of such gaseous fuel is so steadily extending that we may expect in the near future to reach the maximum practicable economy of coal in our greater industries and of smoke abatement as well.

Between the complete conversion of coal into gas and the very partial process included in the production of ordinary illuminating gas is a wide gap which needs to be bridged over in the interests of the small manufacturer and the domestic consumer alike before we can secure that economy in the use of coal which we know to be necessary. For it must be granted at once that our ordinary 16-candle illuminating gas is seldom an economical fuel at an average price of 3*s.* per 1000 cubic feet, though it is capable of being so used as to effect distinct saving under special circumstances. As an example of its economical use, even near the price stated, I may cite the case of the kitchen of St. John's College, Cambridge, where gas and steam have been substituted for coal, and an annual saving effected amounting to about £80. But in establishments which cannot be systematically conducted coal-gas at 3*s.* is too expensive a fuel. Several solutions of this important practical problem have been proposed; one group of suggestions involving the supply of two distinct gases, an illuminating and a fuel-gas, and therefore requiring two sets of street mains; but the progress of electric lighting is so rapid that gas companies would not be justified in outlay of capital on a second set of mains. Another proposal is to supply one gas of high calorific value but low illuminating power at a cheap rate, and this gas, when used for lighting, to be charged at the point of consumption with vapours of suitable hydrocarbides. But the true solution involves a compromise much on the lines along which gas managers are at present apparently working.

You are aware that the average produce of 16-candle gas per ton of coal is about 9500 cubic feet. By the introduction of steam to a small extent the volume of gas can be materially increased, but at the expense of the illuminating power. In order to compensate for this loss, rock or other oils are injected along with the steam, and the illuminating power is maintained. An objection to this practice is that carbon monoxide is present in such gas, but it is also found in many samples of ordinary coal-gas, and provided the gas has a strong and characteristic odour, so that its escape can be readily detected, no risk need attend its use. The supply of the richer bituminous coals is steadily diminishing, hence the practice must grow of supplying a modified water-gas instead of coal-gas as we have hitherto known it. Better far, in the interests of producer and consumer alike, that the inevitable change in the character of the gas manufacture should be carried out with the full knowledge and assent of the public after due Parliamentary inquiry, and in such a manner as to secure the maximum advantage without undue interference with the great monopolies enjoyed by the gas companies. So many satisfactory methods are known by which the illuminating power of a gas can be increased at or near the burner, and gas as an illuminant is moreover being so certainly displaced by the electric light that the objections hitherto urged against the supply of gas of high calorific value but low illuminating power have almost ceased to have any practical force. On the other hand, the supply of a cheap gas of the kind I refer to would prove a great boon to small manufacturers as well as to the domestic consumer, and competent gas engineers inform me that no real difficulties lie in the way.

The rapid extension of electric lighting in our large towns brings us within measurable distance of some such sweeping change in the character of gas used, in its applications, and in its mode of employment, while the existing mains would serve for its conveyance, and comparatively trifling alterations in our domestic appliances would only be necessary.

It is in this direction, then, that the best prospect of solving a considerable part of the smoke fog difficulty seems to lie, and it is in the same direction that we are to look for true economy in the use of coal. The completion of the system of electric lighting in towns is therefore to be desired by the community, not only on account of its great and obvious advantages for illumination, but because it will render possible the provision and distribution of a cheap gas for heating purposes; and the shareholders in gas companies of such fortunate towns should specially rejoice, as herein lies a good prospect not merely of maintaining, but of considerably increasing, their dividends. Gas companies would not only become purveyors of heat energy for domestic use, but for manufacturing purposes as well, not excepting the production of the electric light.

Hence, our duty to posterity and our own immediate interests coincide in requiring the use of more economical methods of using coal, and that which gives promise of the greatest number of advantages involves the conversion of coal as far as possible into gaseous fuel.[1]

I turn now from coal to peat, which is, as you know, a much less mineralized solid fuel. It is obvious that the question of peat utilization is one of much importance in Ireland, as nearly one-seventh of the island is bog. About 1,250,000 acres are mountain bog, and 1,575,000 acres are occupied by flat bogs, which occur over the central limestone plain of the country and stretch away to the north-west. This store of peat is an asset which may become valuable when you shall have exhausted your coal-beds some 170 years hence. We would naturally desire to realize a portion of our assets at a much earlier date, as nearly all the coal used in Ireland must be brought from the eastern side of St. George's Channel. In this fact I think you have some explanation of the depressed industrial condition of the country, as manufactures involving the use of much fuel can only flourish in Ireland if the margin of profit be considerable; where the margin is small and competition keen (as in the greater industries), they must go under in the struggle with manufacturers having cheaper fuel at command. I grant at once that this is no adequate explanation of the absence of many chemical manufactures which do not involve large consumption of fuel, but it is the inevitable result in the cases to which my remarks apply.

Peat alone, however well prepared, compares very unfavourably with coal in several particulars:—

It is a very bulky fuel, in its ordinary condition occupying rather more than five times the space of an equal weight of coal.

2. It contains from 15 to 25 per cent. of water and seldom less than 10 per cent. of ash.

3. At least 2½ tons of average peat are required to perform the same work as one ton of average Staffordshire coal in ordinary fireplaces or furnaces.

Hence the general use of ordinary peat is attended by the disadvantages of requiring much greater storage room than coal, of producing a light and troublesome ash, and requiring more than thirteen times the bulk of coal to produce the same thermal effect. The last-mentioned consideration practically precludes its use in ordinary furnaces where heat of high intensity is required.

Now the force of the first objection to the use of peat, that of bulk, can be materially diminished by mechanical compression. Many excellent examples of compressed peat have been produced at various times, the most coal-like product I have seen being that of Mr. Hodgson, of Derrylea, who compressed, thoroughly disintegrated, and dried peat in heated cylinders, and by partially carbonizing under pressure secured the cementation of the material. Moreover, the ash of such compressed peat was not so bulky as that of the ordinary fuel.

I need scarcely say that the intensity of the heat obtainable with compressed peat is greater than with the loose material, but the actual thermal effect is not much altered, save in so far as the material is drier and therefore less heat is lost in evaporating moisture.

Extended comparative trials of coal and of good dense peat in steam engines have shown that the work done by one ton of peat was not more than 45 per cent. that of one ton of coal; hence if coal were 18*s.* per ton, peat could not compete with it under the most favourable conditions unless delivered at not more than 8*s.* per ton. Now the peat used in these trials did not contain more than 12 per cent. of moisture, but as dug from the bog it seldom contains less than 35 per cent. of water, even when cut from a comparatively dry bog; it must then be stacked and air-dried. The present price of ordinary turf delivered at the bog is about 7*s.* per ton; when to this is added the cost of handling this bulky fuel, and carriage for fifty miles, the cost exceeds 45 per cent. of that of coal even at inland towns; hence there is no real economy in the use of peat of the common kind in ordinary furnaces and grates instead of imported coal.

But the public are led by promoters of peat-manufacturing companies, and others who should know better, to suppose that by certain processes of disintegration and compression peat can be made to approach very closely in fuel value to an equal weight of coal. There is no doubt that a better looking and denser product can be obtained by these means, and one which requires less storage room; but unless artificially dried as well, the actual heating effect of the fuel is not materially altered. I have no doubt that the cost of winning and treating the rough peat could be much reduced by the use of suitable labour-saving machinery; but all methods with which I am acquainted involving artificial drying as well as mechanical compression, have cost so much that the product could not compete with coal at the ordinary level of prices. As I have already said, the Irish peat forms a valuable asset, but one not capable of being realized on any considerable scale at present; at least when used as fuel in the ordinary way as a substitute for coal. But it is possible to so burn peat that it shall compare much more favourably with coal, and this solution of the problem is obtained by converting rough peat into gas.

You doubtless remember that in 1872 the cost of coal advanced even beyond the panic prices which prevailed for a week or two about the beginning of the present year. But the coal famine of 1872 lasted for a considerable time, and serious efforts were then made in Ireland for the utilization of peat. It soon became evident that the continuance of dear coal meant the suspension of several industries and their probable loss to the country; hence, leaving to others the attempts to convert peat into a suitable fuel for general domestic use, I took up the industrial side of the problem.

I saw that the best chance for economically applying peat for most manufacturing purposes lay in gasifying the material in a Siemens furnace, as two special and important advantages must obviously be gained thereby:—(1) The use of peat in the rough state without artificial drying; (2) The avoidance of the injurious effects of abundant ash by burning the peat-gas at some distance from its source, and under such conditions that the comparative value of coal and peat should be nearly in the proportion of their percentages of carbon. I therefore moved the Royal Dublin Society to appoint a committee of engineers and other scientific men to have the value of peat tested in the way proposed. The outcome was that the directors of the Great Southern and Western Railway of Ireland, acting on the recommendation of the able locomotive engineer, Alexander Macdonnell, C.E., decided to erect a complete Siemens regenerative gas furnace for working up scrap iron in their engine factory at Inchicore. This furnace was supplied only with rough peat, often containing as much as 38–40 per cent. of water, but no difficulty was found in keeping the welding chamber at a bright white heat for months at a stretch. The average consumption of fuel was 5·09 tons of peat for each ton of iron forged from scrap to finished work. Before the Siemens furnace was built the ordinary air furnace fed with coal was employed, and the average consumption per ton of iron was 4·96 tons of coal. I need scarcely say that peat is practically useless in such a furnace. Therefore peat used in the gas furnace as compared with coal in the ordinary welding furnace not only proved in practice to answer extremely well, but performed 97 per cent. of the work done by an equal weight of coal. As the price of peat was about half that of coal at the time, Mr. Macdonnell estimated that a saving of £4 7*s.* 9*d.* per ton of finished forgings was effected. If therefore the coal beds were exhausted we have a good substitute in peat for operations in which a very high temperature is required, provided the fuel is used in the gas furnace or according to some similar plan.[1]

The above remarks refer to work done twenty years ago. Now, thanks to the valuable investigations of Mr. Ludwig Mond, F.R.S., detailed in his Presidential Address of 1889, the pro duction of ammonia from peat along with gas according to his method will probably pay for gasifying the fuel and materially facilitate the utilization of peat.

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[1] Since the above was written I have seen a short abstract of Mr. Valon's address to the Institute of Gas Engineers, in which I am glad to find that he takes a somewhat similar view of the situation to that expressed above.

[1] Of course the comparison is more favourable to coal when the latter is used in the Siemens furnace, as it is found that a ton of iron required an average of three tons of coal, therefore the work done by peat was about 60 per cent. of that by coal under the same conditions.

Much to my surprise and regret this work remains the sole practical outcome of our efforts in the direction of peat utilization during the fuel famine of 1872, so far as Ireland is concerned. Manufacturers now know how they can economically use peat for high temperature operations, and Dr. Bindon Stoney, F.R.S., has suggested that peat should be gasified at the bogs and carried to convenient centres of industrial activity. This could undoubtedly be done, especially if instead of 'producer' gas a fuel were manufactured approaching water-gas in composition, and such a gas of good calorific power can be manufactured from peat. Thus, as in the case of coal, peat could be made economically to provide light and heat energy as well for domestic use as for manufacturing purposes. Would that we could apply even a small portion of the energy stored up in peat to stimulate those who should be most active in utilizing in the best and most economical way the abundant material almost at their doors!

If, then, there are many and great advantages in converting our bulky solid fuels into gas and distributing them in that form for heating purposes or supplying power by means of gas engines, it is clear that such advantages must be confined for the most part to towns or special manufacturing centres unless the gases are condensed to the liquid form, and so rendered portable to considerable distances; but nature has already done a great part of this work for us in providing the wonderful material we call petroleum. I do not think 'wonderful' is too strong an adjective to apply to this material, whether we consider its nature, speculate as to its probable origin, or attempt to measure its value in the world's work; and in this, the concluding section of my address, I propose to sketch in broad outline the main points of public interest which relate to this, the most important of our liquid fuels. . . .

The views of geologists as to the nature of the general process by which petroleum is formed are elaborately discussed in the eighth report of the United States Geological Survey, and the conclusions are there carefully summarized (page 506). In substance they are as follow:—That petroleum is derived from organic matter by a process of slow distillation at comparatively low temperatures: that the organic matter was not in all cases of vegetable origin, but was in some instances derived from animal substances in contact with limestone; and, finally, that the stock of petroleum in the rocks is practically complete. It follows, of course, that the supply is exhaustible, but geologists do not even guess at its duration.

In contrast with all this is Mendeleéff's view that petroleum is not a product from organic material, but is chiefly formed by the action of water at high temperatures on carbide of iron, which he supposes to exist in abundance within or below the earth's crust. The cracks and fissures caused by the upheaval of mountain chains permit water to reach the heated carbide at great depths, and carbides of hydrogen result in accordance with the general equation—

$$3\,Fe_mC_n + 4\,mH_2O = mFe_3O_4 + C_{3n}H_{8m}.$$

The hydrocarbides then distil up and condense within the cooler sedimentary strata. The occurrence of petroleum in active volcanic areas, as in Sicily and Japan, is held to accord with this hypothesis, which latter is also consistent with the remarkable fact that rock oil is usually found in the vicinity of mountains. But my chief reason for referring to this attractive hypothesis is that it permits us to suppose the hydrocarbides are still being formed within the earth's shell, especially beneath the geologically modern mountain chains, and that the supply of petroleum is practically inexhaustible. Whether that view can be sustained we must leave further evidence to decide, and now return after this digression to the consideration of the material itself.

The porous strata saturated with petroleum often lie at considerable depths below the surface soil of the district, and the oil is in many cases prevented from rising by a bed or shell of almost impervious material. In boring for the oil this enclosing shell is penetrated and the result often is the ejection of a column of liquid rising as a fountain of several hundred feet into the air. This violent expulsion of petroleum is due in great part to the pressure of pent up gases, and the crude liquid always contains some of these gases in solution. In some instances gas only issues, and a so-called 'gas well' is obtained, from which are emitted enormous volumes of marsh-gas and its lower homologues, as well as hydrogen. Some of these American gas wells afford from 10 to 14 million cubic feet per day, delivered at a pressure of as much as 400 pounds to the inch. Such gas is a fuel of high value and, as you know, has been largely utilized for industrial and domestic purposes at such great industrial centres as Pittsburg.

One million cubic feet of the natural gas obtained from the Trenton limestone at Findlay, Ohio, are said to do the same amount of work in heating as about 60 tons of Pittsburg coal. Some of these gas wells have been exhausted, but others have continued in full productiveness for several years. Although this natural gas is compressed and transported in cylinders to considerable distances, it evidently must remain of almost exclusively local value; not so the liquid petroleum which issues along with it or in its immediate neighbourhood. This is the most portable of all fuels obtainable in nature, and therefore is the most convenient means by which light and heat can be transmitted to all parts of the world—hence it is of greater practical interest to us than the natural gas.

You are aware that the hydrocarbides of which the American petroleum consists chiefly belong to the saturated group C_nH_{2n+2}, whereas those of Russian petroleum are mainly benzenoid hydrocarbides of the general formula C_nH_{2n}, isomeric with the olefines, but really hydrogenized aromatic compounds of the naphthene series. Petroleum from both sources affords some of the lower homologues of marsh-gas, hence in the process of refining crude petroleum by distillation the first products consist largely of butane, pentane, and hexane, which are separated and condensed by pressure, the product being used for refrigerating purposes, owing to its high volatility. Between 80° and 120° American petroleum affords a spirit of specific gravity about 0°·75, and above 130° the illuminating oils are obtained, whose gravities vary about 0·8, while the residue which is not vaporized at 300° includes the heavier lubricating oils, which are also admirably suited for use as fuel, and are cheaper than those generally used for lighting purposes. During this process of refining by simple distillation there is always more or less decomposition in progress, hydrocarbides of high molecular weight being resolved into simpler ones at a comparatively high temperature; and when crude petroleum or its constituents are rapidly heated, this resolution can be carried so far as to convert a large proportion of the oil into permanent gas, valuable alike for illuminating and heating purposes. Thus petroleum is a fuel which can be permanently gasified with facility, and is no doubt wholly converted into gas just prior to combustion in our common lamps.

Several methods are employed for the conversion of oil into rich gas, and storing the latter for distribution through tubes in the ordinary way. In one class of such processes the oil alone is rapidly heated to a temperature of from 800° to 1000° in iron retorts, as in the methods of Pintsch and Keith, thoroughly described by Dr. Armstrong in vol. iii. of our Journal. The yield of gas seldom exceeds 130 cubic feet per gallon, as liquid hydrocarbides of low boiling points are condensed chiefly during the compression of the gas into cylinders for use in railway carriages. The gas is rich in carbon compounds, including methane, ethylene, and crotonylene, and its illuminating power, even after compression, is seldom less than forty-five candles. I may add that Mr. Ivison Macadam has given in vol. vi. of our Journal (p. 199) a valuable series of observations on the gas-producing power of various oils treated by a process very similar in plan to that of Pintsch.

Another mode of converting petroleum into gas includes the use of steam, as in the process of Messrs. Rogers, of Watford, who inject the oil into red-hot retorts by means of steam, the latter appearing to facilitate the permanent change of the petroleum without the formation of much carbon monoxide. The gas so produced is said to amount to about 140 feet per gallon of heavy oil used, and has, according to Mr. Rowan (this Journal, vol. vii), the following composition:—

	Per cent.
Hydrogen	31·61
Marsh-gas	46·17
Illuminants	16·29
Carbonic oxide	0·14
Nitrogen	5·06
Oxygen	0·73

This gas is stated to have an illuminating power of fully 56 candles, and to lose little either by standing or by carriage to considerable distances.

As such petroleum gas has about 3·5 times the illuminating power of 16-candle coal-gas, it follows that, so far as illuminating purposes are concerned, the gas producible from one gallon of oil by this process is equal to some 525 cubic feet of coal-gas of 16-candle value. I shall later on refer to the heating value of this petroleum gas, but I have now justified the statement with which this section commenced, viz., that petroleum is virtually liquefied gas in a peculiarly portable condition. Hence in all states petroleum can be used as an illuminant as well as a fuel, whereas coal and peat can only be used as illuminants in so far as they can afford carburetted gas.

Let me now proceed to justify the further statement that petroleum is the most concentrated, and, on the whole, the most portable of all the natural fuels met with in considerable quantities.

Weight for weight the efficiency of liquid petroleum in steam-raising is much greater than that of coal. The estimates of relative value necessarily vary with different portions of the crude material used, and with the quality of coal employed in the comparative trials; hence some of the statements of results are often rather vague. Thus M. d'Allest found that one pound of refined petroleum evaporated 12·02 pounds of water, while only 6·5 pounds were evaporated per pound of a rather poor steam coal. The American results with crude petroleum and Pittsburg coal gave respectively 15 and 7·2 pounds of water per pound of fuel. Prof. Unwin has recently compared petroleum with Welsh coal in steam-raising, the oil being injected by a steam jet through a highly heated coil and then burned perfectly with a clear flame. In his trials with a not particularly efficient boiler he found that 12·16 pounds of water were evaporated per pound of petroleum, and this result he considers about 25 per cent. better than that afforded by the steam coal. These results agree with those of M. d'Allest so far as the effect of petroleum is concerned, but the coals compared were different in value for steam-raising. Hence for an average coal the proportion is nearly three to two; in other words the practical heating effect of one ton of coal can be obtained by the combustion of only two-thirds of a ton of petroleum, while the comparison with the heavy oils would probably be still more in favour of liquid fuel. Petroleum has another advantage over coal in the matter of storage room, as one ton of the liquid occupies only four-fifths of the space of the same weight of coal, so that the bulk of the petroleum required to perform the same work in heating as one ton of average coal is little more than half that of the latter. It follows that a steamer constructed to carry 1000 tons of coal could, if provided with suitable tanks, carry 1200 tons of petroleum, equal in fuel value to about 1900 tons of coal. In addition, the liquidity of petroleum permits it to be pumped and conveyed long distances by gravitation in tubes so that its transport in bulk and in detail is easy. Therefore petroleum is not only a much more concentrated fuel than coal, but it is eminently portable as well and convertible with much greater facility into permanent gas. Against these advantages must, however, be set the inflammability of petroleum, and consequent greater risk of fire.

Now we have to consider the question of relative cost of petroleum used as fuel in liquid or gaseous form as compared with coal—the latter being our standard for reference as in the case of peat. We have already seen that about two-thirds of a ton of petroleum can do the same amount of work in heating as one ton of coal; therefore petroleum, when burned directly, cannot economically replace coal unless two-thirds of a ton of the liquid can be purchased for less than the cost of one ton of coal. We know the cost of ordinary lamp petroleum in these islands is at present far beyond that limiting value; even the heavy oils which are not good enough for lamps, and yet are too 'thin' for lubricants, only compare favourably with coal where the latter has to be carried long distances, and is therefore dear. However, all practical difficulties having been overcome in the use of these heavy oils for steam-raising, a comparatively small advance in the general price of coal would at once render them economical for industrial use as fuel.

But when we compare petroleum gas with ordinary coal-gas the comparison is much more favourable to the liquid fuel; unlike coal, petroleum is already more than half-way on the road to conversion into gas. As you know, one ton of coal affords about 9500 cubic feet of 16-candle gas. On the other hand, one ton of oil of sp. gr. 0·85 can afford about 24,000 cubic feet of gas, having an average illuminating power of 60 candles, or the equivalent of about 70,000 cubic feet of 16-candle value, and this rich gas admits of preparation on the small scale suited to country places, while the retorts used in the production of the gas can be heated by petroleum. The petroleum gas of some 60-candle power is said to be producible at about 6s. per 1000 cubic feet. If we were to assume that the calorific value of the gas is directly proportional to its illuminating power the cost would correspond to about 1s. 7d. per 1000 cubic feet of 16-candle coal-gas. But the facts do not justify the assumption, as the calorific value of methane is known to be greater than that of the heavier carbides to which the high illuminating power is due; hence the comparison is probably less favourable to petroleum gas by about 25 per cent., though further experimental evidence is wanting on this point. However, even after this deduction, petroleum gas is the cheaper fuel as well as illuminant.

The necessary links between the elements of the trilogy on coal, peat, and petroleum are now, I think, sufficiently evident. If we desire to use each fuel in such a way as to develop most economically and conveniently its store of heat energy, we must first partially or perfectly gasify it. The newest member of the triad—petroleum—is the one which lends itself most easily and completely to such treatment, in consequence of its physical condition and chemical characters. It is also the material that we must expect to facilitate the production of cheap gaseous fuels from coal and peat which shall at the same time possess sufficient illuminating power for most purposes. Chemical industries would probably benefit to a greater extent than others by the supply of cheap fuel of the kind in question; hence I have ventured to tax your patience by dwelling on this topic in your presence to-day.

SUGAR-CANE BORERS IN THE WEST INDIES.

MR. BLANDFORD'S report on sugar-cane borers, published in the *Kew Bulletin* for July and August last, deserves more than a passing notice.

The report contains a plate of the insects in question, which will render their identification easy.

The first is a caterpillar and moth, *Chilo saccharalis*; the second a weevil, *Sphenophorus sacchari*; but the principal attention in the report is paid to the shot borer, *Xyloborus perforans*, a beetle which has lately caused considerable loss to growers of sugar-canes in Trinidad. These losses have been so large that on some estates thirty per cent. of the sugar crop has been destroyed, and in some fields fifty per cent., presumedly by the devastations of this beetle.

This beetle *X. perforans* is to be found over a very large area in the tropics; it is the same species that has done so much damage to wine and beer casks; it has been found in India, the Malay Archipelago, Madeira, Mauritius, North and Central America, Brazil, Guiana, Peru, and probably in Australia, so that no sugar-producing country can consider itself free from the fear of its ravages.

Mr. Blandford's report is interesting and valuable, not only for the amount of information it gives relative to this most destructive insect; but also for the way in which he points out what remains still to be investigated on the subject; so that it not only furnishes valuable information to the planter in the West Indies, but also tells him what course his further investigations should take; and it might well serve as a model to future observers in drawing up similar reports.

"The chief subject for investigation," to quote Mr. Blandford, "is the relation of the insect's attacks to the health and condition of the canes, whether it (the shot borer, *X. perforans*) is a true destroyer, or merely a follower and manifestation of antecedent and more serious injury:" this question, Mr. Blandford says, "I do not attempt to solve; it can only be studied in all its bearings by observers on the spot;" and he further gives a list of definite points which require inquiry and solution.

There is no doubt that the presence of *X. perforans* is usually accompanied by the sugar-boring caterpillar, *C. saccharalis*, and the weevil, *S. sacchari*, and also with fungoid growths, which may of themselves account for the acidification of the juices of the cane, which is apparent in canes attacked by the shot borer; but whether or not the shot borer attacks healthy canes is a question on which there is much diversity of opinion, and we hope that bringing the question before our readers will lead to more observations and experiments to decide this important question, as "while there is no proof, there is a strong presumption that *X. perforans* cannot begin the attack." Still there is much difference of opinion, as the Trinidad Commission, which investigated the subject, "believes that the beetle is the primary cause of the disease, and that it is immaterial whether the cane is healthy or not;" others believe that it is only canes which are "already physically weakened by other causes which are attacked by it."

The Transparent Cane and Caledonia Queen enjoy an entire immunity from the attack, "even when growing side by side with badly infested Bourbon canes, and varieties raised by seed show no signs of being attacked." It is therefore suggested that perhaps the Bourbon cane, enfeebled by long cultivation on the same lands and degenerated by careless ways of propagation, has become powerless to resist the attacks, and planters in their investigation must consider the possibility of attacks "being favoured by constitutional weakness which in no way implies want of care in cultivation, but perhaps the reverse."

The enemies of the shot borer are still to be found.

An important lesson taught by this report to the planter is the necessity of varying the description of canes grown and the great value of the new seed canes raised in Barbados.

S. N. C.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, Sept. 19.—M. Duchartre in the chair.—On the white rainbow, by M. Mascart. This phenomenon, usually known under the name of Ulloa's circle, is explained, not on the untenable assumption of water vesicles, but of very minute drops as constituting the mist upon which it is seen. The diminution of the diameter of the drops causes a displacement of the first maximum of the interference fringes which produce the supernumerary arcs. The relative intensities of the various colours retain equal values long enough to make the rainbow appear achromatic, with perhaps a slight red coloration along the outside. The radius of such a circle has been known as small as 33° 30'.—Observations of the new planet Wolf (1892, Sept. 13), and of the planet Borrelly-Wolf (Erigone?), made at the observatory of Paris (west equatorial), by M. Bigourdan.—On a recurring series of pentagons inscribed to the same general curve of the third order, by M. Paul Serret.—On the production of the spark of the Hertz oscillator in a liquid dielectric instead of air, by MM. Sarasin and De la Rive. The two balls of 3 or 4 cm. in diameter, between which the Ruhmkorff discharge takes place in the Hertz oscillator, were plunged into an insulating fluid. This was, in the first place, olive oil, contained in a cylindrical vessel, 20 cm. in diameter, pierced laterally to admit the end branches of the oscillator. Sparks 1 cm. long were obtained, giving a characteristic sound, louder than that of a discharge through air. The effect on the resonator is notably increased by the arrangement, most brilliant sparks being produced. The interferences of the electric force by reflection from a plane metallic surface give the same results as in air. During the discharge, the oil is carbonized and loses its transparency, but without affecting the intensity. Similar experiments were made with essence of terebenthine and petroleum, but the oil proved the safest and most advantageous medium.—The action of bromine in presence of aluminium bromide on the cyclic chain carbon compounds, by M. W. Markovnikoff. It has been shown that a small quantity of bromide or chloride of aluminium added to the bromine produces a vivid reaction with the carbon compounds of the aromatic series, usually resulting in substitution-products of a crystalline form. Further experiments show the generality of the reaction for all the hydrocarbons of the series C_nH_{2n} which were examined. It has been studied chiefly as regards the naphthene (hexacarbon) series, and may be expressed by the general equation—

$$C_6H_{12-n}B_n + Br_{12-n} = C_6B_{6-n} + 6HBr.$$

The rule seems to be that the action of the bromine on the naphthenes at the ordinary temperature takes place principally on the hydrogen atoms of the cyclic chain, transforming them into benzene nuclei, in which all the hydrogen atoms are replaced by bromine, whilst the lateral chains remain intact. It is found that besides the bodies of the aromatic and naphthene series, the hydrocarbons of the paraffin series also react easily in presence of $AlBr_3$.—The rotatory power of fibroin, by M Leo Vignon.—Experimental researches on the bulb centre of respiration, by MM. J. Gad sand G. Marinesco.—Influence of continuous and discontinuous electric light upon the structure of trees, by M. Gaston Bonnier. Out of three lots of plants, one was submitted to a constant electric illumination, another to an illumination alternating with twelve hours' darkness, and a third was left to develop in ordinary daylight. The experiments were carried out in the electric pavilion of the Central Markets at Paris. The temperature was pretty constant (between 13° and 15°); the light was given by arc lamps in shades, and the trees—pines, beeches, oaks, and birches—were surrounded by glass, the air being gradually renewed. It was found that continuous electric light produced considerable modifications of structure in the leaves and shoots of the trees. The plants breathed, assimilated, and secreted in a continuous manner, but they appeared as if encumbered by this continuity, and showed a simpler structure. The shoots were very green, the leaves more open, less firm, and smaller. Differentiation was less decided in every respect. In the specimens exposed to intermittent illumination the results were very similar to those obtained under normal conditions.—On the discovery of the line of no declination, by M. W. de Fonvielle. From an inspection of geographical maps preceding or contemporaneous with the discovery of America it appears certain that Columbus was the first to discover the variation of the compass. Indeed, it was the rapidity with which the observed declination diminished which produced consternation among his seamen, whom he could only save from a panic by persuading them that the pole star had changed its place, while the needle remained a true guide. The stratagem succeeded, but Columbus suspected that the radius of curvature of the earth was different at the Sargasso sea, and that the line of no declination represented a natural frontier between the territories of Europe and Asia. This natural frontier was adopted by the Pope Alexander VI. in his division of the new world between the rival aspirants. Columbus himself found that the line did not coincide with a meridian during his third voyage, but the illusion guided even Magellan, and was only dispelled by Halley's magnetic chart in 1700.

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THURSDAY, OCTOBER 6, 1892.

NATURAL SELECTION AND ALTERNATIVE HYPOTHESES.

Animal Coloration: an Account of the Principal Facts and Theories relating to the Colours and Markings of Animals. By F. E. Beddard, M.A., F.R.S. (Swan Sonnenschein & Co.)

THE theory of natural selection has been pre-eminent for over thirty years as the most generally accepted explanation of organic evolution. It has, and has had throughout, many critics; but its position is strengthened by the fact that these critics invariably accept the principle as accounting for something, while most of them make it clear that they reject all other proposed substitutes, except those for which they are individually responsible. Sometimes the attempt to formulate an alternative hypothesis, or to apply it to the facts of nature, breaks down as soon as it is undertaken. A curious instance of this is to be found in Semper's "Animal Life," which begins with very large anticipations:—all the "popular cant" of the Darwinian is to be "put out of court as useless"; a selective explanation can never be a real one, but for the latter we are to consult the subsequent pages. But as case after case is examined, the author is constrained to admit that his real explanation is not forthcoming, and that, although he never will think much of selection, it is the only cause he has to offer. Semper would appear to have written his preface before he considered the materials from which he proposed to write his book.

Mr. Beddard's work does not open in this ambitious manner, but he is far bolder in offering alternatives to natural selection, and in applying them. Further consideration would probably have brought him to Semper's admission, at least as regards many of his suggestions. Indeed, the number of these suggestions, and the confidence with which they are brought forward, are clearly due to haste and want of sufficient reflection, which also leave their mark upon the scheme of the volume and the number of contradictory statements to be found in it. Nor is this to be wondered at when the amount and variety of work which the author accomplishes is borne in mind. But the result will be to confuse the beginner and the untrained student. Principles which are supposed to be refuted in one part, are subsequently introduced with considerable enthusiasm as the heads of the main sections of the work, and are later on again treated with scant courtesy. In fact some readers will rightly infer that the author is a profound sceptic as to the value of the scheme he nevertheless adopts. Others may perhaps be led to suppose, by the arrangement of the book, that the author is sceptical of his own scepticism. Even the very fairness of the author in giving the arguments in favour of views he rejects, will be, such is the system pursued, a cause of confusion to a reader. These sources of difficulty are not only apparent in the general scheme; particular explanations are disputed in one part, and adopted a little further on without a word of explanation.

The chief value of the book lies in the fact that it is straightforward, and speaks out on points of great difficulty and dispute. Arguments of which echoes have been already heard, perhaps, in the report of some conversation which is supposed to have taken place, or which have been crudely stated in the publications of unknown writers, are here met with in a form in which they can be dealt with. For thus stating the opinions which are vaguely supposed to be held, perhaps vaguely held, by others, every Darwinian owes a debt of gratitude to the author.

The main aim and purpose of the book would appear to be a criticism of natural selection as applied to the explanation of the colours of animals, and the proposal of alternative explanations.

Some of the difficulties which the author finds in the theory of natural selection appear to follow from his conception of the process itself. Thus, on p. 12, he speaks of polymorphic species appearing in two or more well-marked forms, and of those extreme cases of variation known to entomologists as "varieties," and concludes, "In fact, if colouring were really constant for a given species, there would be no chance for natural selection"; thus implying that natural selection depends upon such pronounced divergences, instead of upon those minute differences which distinguish the individuals of every species. He then continues, "Supposing that a marked variety occurs in a wild species, there is, first of all, a considerable chance against its reaching maturity; secondly, there is a considerable chance against its finding a mate; thirdly, the hereditary influences on both sides are against the perpetuation of the variety. These appear to be more potent causes of the comparative fixity of colours in wild animals than the unfitness of the varieties to live." It has already been pointed out that the "marked variety" is of little importance for natural selection as compared with the individual difference. But if the objections urged were valid there would appear to be little chance of a "marked variety" existing in any numbers and persisting from generation to generation, side by side with the normal form: and yet numbers do persist. As to the first of the alleged objections, the chances are against *every* individual, but not equally so, if there be anything in natural selection. So far from this objection being valid, it is but the expression of a fact upon which natural selection rests, the fact that many more individuals of every species are born into the world than can by any possibility survive. Were this not so all selection would cease. The second difficulty certainly does not apply to minute individual differences which occur in vast numbers. To take the simplest case, let us suppose that the individuals of a species are divided, as regards any character, into two equal groups—the one above, the other below the mean. It is clear that each individual would stand as good a chance of mating within the limits of its own group as within those of the other. The third objection does not appear to me to hold in the case of "marked varieties" any more than with individual differences. The total hereditary influence of the varying side, allowing even considerable force for atavism, is certainly in favour of the variation. Furthermore, experience shows us that among the offspring will be some that vary even further than their parent. Those who accept the Darwinian principle do not expect heredity to achieve more than this—to offer the materials which can be accumulated by natural selection.

Interesting as is the study of such "marked variations" and the statistics of their occurrence in nature, the great principle of natural selection, whether applied to the evolution of animal colouring or to any other character, is not greatly affected thereby, but rather demands such exact numerical investigations as those published by Galton upon man, by Wallace upon various animals, by Weldon upon *Crangon*, and by Lloyd Morgan upon bats.

Another objection to the natural selection argument is given on p. 25, and it too turns on the author's conception of the mode in which this principle operates. Recapitulating Weismann's argument that longitudinal stripes have been replaced by oblique ones in certain larvæ, on account of the more perfect concealment afforded by the latter, he points out that some species "have, on the contrary, remained at a stage of coloration which is, *ex hypothesi*, disadvantageous." The longitudinal striping was never disadvantageous, but only relatively less advantageous, in certain species, and under certain conditions. The failure of a species to take this line of evolution may have been due to many causes, the development of other modes of defence, the nature of its peculiar environment, or may be solely due to the kind of selection exercised by its foes.

The author sees far-reaching conclusions against the principle of natural selection in the admission that pigment as a cause of colour was originally non-significant, and is so still in many cases (colours of certain lower forms, colours of blood, fat, &c.). He argues (pp. 68-70) that as colour did not arise by natural selection, it must be a normal product of the organization, and its disappearance in cave-dwelling forms cannot be due to the cessation of selection, but must follow as the direct effect of surroundings, although he does not even hint at the mode in which such effects are supposed to be wrought. But these conclusions are by no means warranted by the original admission. The first appearance of pigment in the skin of the ancestor of a group of species which are now coloured was certainly a normal product of the organization; but the fact that this variation subsequently spread over all the individuals of the ancestral species, and of those to which it gave rise, will be claimed by Darwinians as the result of selection. And so strong are the tendencies of variation in other directions that partially or completely albino races can be produced by man in a relatively short period of time, while such individuals are far from uncommon in nature in spite of selection. The facts support the opposite conclusion that the absence of colour from the skin would be the normal result of organization for the average individual, were it not for the strong and continuous action of selection. There are other instances of the disappearance of colour in addition to that which has occurred in caves, and in some of these the conclusion appears inevitable. The whiteness of birds' eggs laid in dark holes certainly cannot be traced to the direct action of surroundings, any more than the colour of eggs laid in open nests; and natural selection being prevented by man, the colour is disappearing from the eggs of the domestic fowl, just as it is lost in other species when prevented by darkness.

It is certainly true that colour "must be there before it can be acted upon, and modified in this or that direction according to the needs of the animal." But this objection, which has been familiar since the earliest days of natural selection, is less formidable than it appears to be. Colour must have been present in the skin of some individual ancestor certainly, but its *existence*, as well as its modification, in the normal individual of the species is to be explained by selection.

It is hardly necessary to point out that this argument does not apply to colours which still remain non-significant and are excluded from selection; but these are precisely the colours which are unaffected by the changes of environment alluded to above; the blood of cave-dwelling vertebrates remains red like that of others; the yolk of eggs laid in holes does not differ in appearance from that of those laid in open nests.

A similar argument as to seasonal change of colour in arctic animals may be answered in the same manner.

The author's difficulties appear to arise in part from his inadequate conceptions of the struggle for existence. Speaking of certain night-feeding caterpillars, he says (p 102): "It may be suggested that they prefer to feed early in the evening, when their colours, if conspicuous, would be readily seen. If this is so, it does not much matter, for the birds would—the bulk of them at any rate—have gone to roost." Or speaking of *Mimnonectes*, an Amphipod crustacean which bears a remarkable likeness to a *Medusa* well defended by stings, he objects to attribute any significance to so wonderful and detailed a superficial resemblance, because "a school of whales or a shoal of pelagic fish, rushing through the water and devouring all before them, could hardly be supposed to stop and analyze carefully the advantages or disadvantages of selecting or rejecting a given animal as food." On p. 115 he remarks: "If Mr. Poulton is right in assigning a protective value to the bright-coloured wings of butterflies, 'as a conspicuous mark easily seized by an enemy, and yet readily tearing without much injury to the insect,' it seems unnecessary to pay much attention to the supposed utility of protective colours, such as are shown by the *Kallima* or the Green Hairstreak."

The author scoffs at natural selection as an "easy" road to an explanation, as "the very simple hypothesis of a need for resemblance to the environment": it may at any rate be maintained that this method of meeting it is very far from profound.

It is only possible to give a very brief account of the causes which the author would propose to substitute for natural selection. The merits of each proposal lie in its application, and the consideration of this means a discussion of each particular case.

In support of the "effects of food upon colour," a number of examples are quoted, many of which are so inherently improbable and so imperfectly supported by details, that it is impossible to accept them as evidence. I am very far from disputing that changes of colour may be directly produced by certain foods, although the significance of such changes in the evolution of animal colouring is a very different matter. When the author proceeds to apply this principle he falls into errors which a little consideration would have avoided. Thus, on p. 21, the following sentence occurs:—"Seeing that pigment has been proved in so many cases to be alterable by changes in the food, it is not surprising to find that as a rule the colours of larvæ are totally different from those of the adult form;" implying that the difference of diet accounts for the difference of colour,—a conviction stated even more strongly on the next page. It is quite sufficient answer to this hasty conclusion to point out that the colours of the imago are just as dependent on the larval food as the larval colours themselves, and that they have made their appearance long before the imago has had the opportunity of feeding. Again, in speaking of the "strong superficial likeness" of the Drone-fly (*Eristalis tenax*) to a bee, the author hints at likeness of food as a possible explanation (p. 232). "It is an interesting fact, in connection with the resemblance between this fly and a hive bee, that it feeds upon pollen and honey. This fact *may* have some significance in relation to the effects of food upon form and coloration." But the form and coloration of *Eristalis* depend upon the food absorbed by its "rat-tailed" larva, living in putrid mud, under conditions utterly unlike those of the larval bee.

Under the consideration of light as a cause of colour an extremely bad piece of reasoning is adopted from Werneburg (p. 62), who argues that light has an important influence on the formation of pigment during the pupal period. By selecting favourable instances and describing them with an enthusiasm which borders on inaccuracy (*e.g.*, speaking of *U. sambucaria* as "bright yellow") and by neglecting all others, he makes it appear that there is something to be said for this view.

In the section on "Variable Protective Resemblance in Chrysalids," the results of recent work are given very inaccurately; the golden colour of pupæ is explained as due to "thin films of air or some gas," and it is even suggested that "intense light may cause some gas to be given off in greater abundance." But it was shown years ago that the appearance is due to some lowly refractile liquid, and, in fact, alcohol answers the purpose very well indeed. Gases do not appear to have the power of entering the intervals between the cuticular lamellæ, perhaps because the latter come together and obliterate the chinks on the evaporation of the fluid. Again, it is stated that "the pupa was also made to assume a light colour upon one half and a dark colour upon the other." As a matter of fact the invariable failure of the pupa to do this formed the basis of some of the principal conclusions reached. It was also surely unnecessary to quote an ignorant assumption of Eimer's on the subject—an assumption which was not even original, and has been disposed of long ago.

In favour of the effects of climate reliance is placed on Scudder's conclusion that melanism is only found in the butterflies south of New York, albinism only to the north (p. 55). And yet in Europe melanism is especially prevalent among the northern moths, from which we may infer that the American observations, however they are to be explained, are not direct effects of climate.

He suggests that the blackness of a lizard on one of the Canaries may be due to moisture; but these islands are about as dry as small oceanic islands can be. All the lizards seen by the present writer in Teneriffe and Grand Canary, some three or four species, were dark in colour and harmonized with the tint of the dark dry volcanic rocks on which they were seen, and among which they almost invariably escaped when pursued.

One suggestion is very remarkable. After giving reasons why he does not consider that the resemblance of *Volucella* to humble-bees, &c., is to be explained as a case of aggressive mimicry, the author suggests (p. 228), "If wasps and bees have the same unintelligible liking for keeping pets that another group of Hymenoptera—the ants—have, the whole series of facts may prove to have a very different meaning, but one which is not quite in accord with the theory of mimicry on the part of the *Volucella*." The keeping of pets by ants is so very far from being unintelligible in some of the most important cases (*Aphides*, Lycænid larvæ, &c.) that we may fairly expect an explanation in other instances. But even if the author's suggestion were valid it would still fail to account for the very point at issue—the great superficial resemblance of *Volucella* to Hymenoptera.

On p. 92 he is quite prepared entirely to dispose of all advantages in the struggle for existence in favour of fertility; this alone is enough to prevent extermination. Speaking of the wonderful disguise of Geometer larvæ (and if this be not the result of selection it must be admitted that the principle fails indeed) he says, "In the meantime the excessive fertility of the parent moths appears to be a sufficient guarantee against extinction, apart from any subsidiary advantage to be gained by colour protection." It is sufficient reply to this statement to point out that the fertility of these small-bodied moths is very far from excessive when judged from an insect standard; that if the larvæ are offered to any insect-eating animals they are when detected, devoured with the greatest avidity, but that if offered motionless on their natural food-plant they are often passed over; that insect-eating animals, especially when rearing their young, are by no means fed to repletion, so as deliberately to refuse the food they evidently relish.

It is very confusing after this candid avowal to read a few pages further on (p. 97), "On the whole, it seems more profitable to a caterpillar to adopt protective resemblance to its surroundings as a means of escaping its foes; at any rate, this is what actually occurs. 'The main purpose in life of a caterpillar,' says Mr. Scudder, 'next to feeding, is *not to be seen*.'"

Many quite irresponsible suggestions, which it would have been wiser to have withheld unless accompanied by at least some evidence, are made or adopted from other writers. Of this nature are the remarks of Leydig on the colours of *Helix nemoralis*, and the author's suggestion that the dark variety of the female Silver-washed Fritillary may be due to the moisture of wooded districts.

Of some of the author's suggestions we may use his own words, and say, "This explanation has an air of reasonableness, which might lead to the inference that it had been amply tested by actual experiment" (p. 64). Others however, including some which have been quoted here, certainly appear to lack this "air of reasonableness."

The author is especially candid and straightforward in bringing forward the evidence in favour of an explanation he is about to attack. After thus fairly showing the strength of the opposed position, he proceeds to reject it for reasons which will strike the instructed and uninstructed reader alike as singularly inadequate. Examples of this method occur continually throughout the volume. As an example may be selected his treatment of the opinion that the light of phosphorescent organs enables certain deep-sea animals to see. He admits the existence of eyes, the prevalence of phosphorescence, the intensity of the light emitted, the existence of "lens-like transparent bodies serving to concentrate the rays of light," the fitness of the light to illuminate the prevalent colours. In spite of all these facts the author believes that all deep-sea colours are unseen and meaningless for the following remarkable reason:—"The presence of well-developed eyes, or the total absence of these structures, are, as has been explained, intelligible on the theory of abyssal light; not so the existence of eyes in an intermediate condition. The inevitable conclusion, therefore, from these facts appears to be that the brilliant and varied coloration of deep sea animals is totally devoid of meaning; they cannot be of advantage for protective purposes, or as warning colours, for the simple and sufficient reason that they are not seen" (p. 37). The author carries this conclusion to its logical end, and, pointing to the resemblance of deep-sea forms to their shallow-water allies, and the existence of protective resemblances in both, he maintains that "if natural selection has been the cause in the one case, it ought to be in the other. . . . . The question therefore is pressing: need natural selection be responsible for the coloration of the shallow-water forms?" (p. 38). A somewhat large conclusion to base on the fact that the eyes of certain deep-sea animals are in process of degeneration! The author admits that the *absence* of eyes is no argument for his views; and yet, in every such instance, a gradual process of degeneration has been passed through. He gives us no reasons for rejecting the opinion that the cases upon which he bases such startling conclusions are merely tending in the same direction; indeed, elsewhere (p. 11) he insists on the probability that such biological changes are still progressing. It is indeed most probable that light is far from widespread or intense on the floor of the ocean, and that, therefore, eyes to be of use must be unusually efficient, while, unless absolutely necessary, they are likely to disappear. We meet, in fact, with a case somewhat parallel to that of beetles on oceanic islands in tempestuous zones, where selection operates in opposite directions—towards unusual powers of flight, when flight is a necessity, and towards the total loss of any such capacity when it is unnecessary. Thus, among deep-sea fish we find eyes of immense relative size, as well as those which are degenerate. And the phosphorescent organs of certain fish (*Ceratias*) appear to emit a light which is invisible to the degenerate eyes of the possessor, but serves to attract other and better endowed fish upon which the *Ceratias* feeds. The frequency of this degeneration among the deep-sea Crustacea, which impressed the writer so profoundly, may very probably be due to conditions of life which render vision less necessary for them than for many other groups, and this is especially probable since many shallow-water genera are sightless, as is abundantly shown in the book itself (p. 36).

On pages 115, 116, the author adopts Prof. Weldon's objection to the usually received interpretation of the whiteness of certain eggs, and the under-sides of fish, porpoises, &c., which are seen from below, on the ground that snow-flakes appear almost black when seen from beneath against the bright sky. The original suggestion is due to neither Mr. Wallace nor to the present writer, but to Erasmus Darwin, writing very nearly one hundred years ago. The objection entirely misunderstands the hypothesis, at any rate so far as the eggs are concerned. If an egg, lay exactly over one of the interstices in the nest, it would, of course, shut out the sky altogether, and when viewed from some distance through the opening would appear dark like the nest itself. There would be no question of its appearing against a back-ground of sky. As a matter of fact, no such continuous back-ground can be seen through the nest at all. Minute bright points are seen through the interstices of the nest, and those of the leaves and branches above and below it. The hypothesis in question suggests that part of the bright white side of an egg, viewed obliquely from below through an interstice, may be mistaken for one of these bright points. The hypothesis may be erroneous, but it is not to be set on one side by a criticism which fails to understand it. In the case of the fish, the question is complicated by the absorption of light by the layer of water.

The reader who finds that the above-quoted criticism is held to be destructive by the author, may be excused strong language when he meets with the following sentence only seven pages further on:—"Among pelagic fish it is common to find the upper surface dark-coloured and the lower surface white, so that the animal is inconspicuous when seen either from above or below."

The chapter on Warning Coloration is one of the most valuable parts of the book, for in it we meet with a solid contribution to the subject in the form of some interesting experiments conducted by the author upon the animals in the Zoological Gardens. Many of the results are of extreme interest, and are a further proof of the difficulty of the investigation, and the great care with which it must be conducted if the conclusions are to be depended upon. It has been already suggested that some of the results may be perhaps explained by the fact that the insect-eating animals chosen for experiment are restricted to a very monotonous or very scarce insect diet. In some rather extensive experiments made by the present writer upon a marmoset, it appeared that the animal possesses a most keen appreciation of the meaning of warning characters, but the individual in question was accustomed to be fed on a very varied diet. The discussion of the details given in this chapter cannot now be attempted, but it may be safely affirmed that there is nothing which is fatal to the theory of warning colours, when we admit, as we are of course bound to do, that even unpalatable animals have their special enemies, and that the enemies of palatable animals are not indefinitely numerous.

Further criticism of the arguments is rendered impossible on the present occasion by the exigencies of space. Certain obvious misstatements call for correction, such as the description of the jet black larva of the Peacock Butterfly as "dusky greenish" (p. 21), the assertion that the present writer discovered uric acid in the excreta of Vanessid imagos (p. 41), the implication that leaf-mining larvæ eat only the deeper tissues of the leaf instead of everything between the upper and lower cuticle (p. 63), the description of "red eye-like markings upon the blue underwings" of the Eyed Hawk Moth (p. 134), in which red and blue should of course be transposed.

The book is well printed, misprints such as "Tortorix" for "Tortrix" (83), "freshly-moulded" for "freshly-moulted" (67), "distinction" for "distinctive" (185) being fortunately uncommon.

The coloured plates are good, although it would have been a pleasure to see the wings of one of the resting *Volucellæ* in Plate IV. folded one over the other in a very characteristic attitude. The antennæ of the *Kallima* shown at rest in Plate II. would have been concealed, and the same applies to the figures of the Buff-tip and Lappet Moths. The worst figure is that of the Bee Hawk Moth on p. 245, in which an entirely wrong notion of the opaque border to the wings is conveyed. The source of the figures is not mentioned.

EDWARD B. POULTON.

SUNSHINE.

Sunshine. By Amy Johnson, L.L.A. (London: Macmillan and Co., and New York, 1892.)

THIS book is likely to puzzle any one who may by chance pick it up and glance casually over the pages, more especially if he should happen to first open it towards the end and find two chapters headed "Tommy's Dream," concluding with a conversational account of how "the nurse puts baby into a bath, generally too hot or too cold, and scrubs away as if he were a wooden doll. Poor baby's skin is red all over, and he screams with pain," &c. On the other hand, in the early part of the book, several familiar figures, such as pictures of ice flowers, or diagrams of the action of simple lenses, of total reflection, of the rainbow, &c., show that "Sunshine" is, in spite of the nursery episode, in reality connected with physical science. As a matter of fact the authoress has taken a number of easy experiments and every-day observations, and has amplified and explained them in a simple and often very charming manner, adopting for the purpose the conversational form as between herself, called teacher, and, judging by the number of Christian names of the children addressed, a host of youngsters.

The conversational style is out of fashion just now, but no objection can be taken on that account. What is of far more importance is the general effect produced upon the mind of the child. The writer of this notice well remembers how the attempt was made to beguile him into being interested in conversations between a horridly precocious child Willie and his papa. Willie always said the right thing, and always made the right mistakes, so that much instruction was to be gathered from the answers and corrections of his papa. The writer, no doubt, did acquire some general information; perhaps he did not resent the attempted deception, but he is sure that he would like to have punched Willie's head, or to have made him suffer in some way that is pleasing to the boyish imagination. In the present instance the risk of arousing open hostility on the part of children who may receive instruction from the pages of "Sunshine" is largely reduced by the fact that the conversation is very one-sided; the children are made to say very little in these talks—they are not quite lectures, but more lectures than conversations. Whether "teacher" says too much, or in the attempt to appeal to the imagination rather than the reasoning faculties of her audience rambles too far afield, is a question of taste. Many parts of the book demand the highest praise, though in some the authoress seems to have gone beyond reasonable bounds. For instance, after a most clear and excellent illustration of the method by which the distance of the moon from the earth is determined, in which the children are made to find by folding paper how far it is from the table to a ball hanging up in the room, the imagination of the reader is stimulated as follows:—

> "At the beginning of our 'talk' about the moon, I tried to impress upon you what old travellers you were. Do you remember how far you have been each year? (585,000,000 miles.) And you, Tom, are——?" "Seven." "What age are you, Percy?" "Eight." "And you, Minnie?" "Nearly eight." "You shall work that sum out for me on your slates. We will neglect the travelling since last birthday. Multiply 585,000,000 by 8, Percy. Four thousand six hundred and eighty millions of miles, you say. Have you felt any pain or sickness? Are you willing then to accompany me for a little 'out' to call on our next neighbour, the moon? It is only 240,000 miles, and would take us a little over three hours and a half at earth's usual rate of travelling. Do you think your mothers would trust you with me if I guaranteed to bring you safely back again? Most of you say 'Yes.' What is it that Ethel is saying to you, Lucy?" "She wants to know if we are really going, or if it's 'only pretending.'" "That is a question which Ethel must decide for herself. Those who are going with us must be ready in time, or they will be left behind. Before we make a journey it is usual to consider, not merely the distance, but a few other matters also, such as—'What to take with us,' 'How long we shall be away,' 'Where we can get lodgings,' 'Whether we should take shawls, umbrellas, &c.,' and so many other considerations, that I am afraid we can't go to-day. Make all inquiries at home, and let me know how many of you are prepared to go."

As has been stated, the imagination rather than the reason is being constantly appealed to, and for the purpose the most picturesque language is employed. Perhaps the most striking example is to be found in a chapter headed, "The Mill with Stained Glass Windows." A beam of sunlight is made to pass through a condenser and into a slit. Then slips of coloured glass, red, green, and violet, are placed edge to edge over the slit, and the red-green-violet line of light is looked at through a scratch in a piece of smoked glass. The resulting diffraction phenomenon is the mill with stained glass windows. The upper story with violet windows has a greater number closer together than the second story with the green windows, and there is the same difference between this and lower story with the red windows. From this result by a simple step the coloured bands seen when white light is employed are readily explained. Of course, and wisely so, no attempt is made to explain why with monochromatic light the windows are seen at all. In the same manner most of the phenomena described or which can be observed by following the clear and simple directions are stated to be what they are, rather than proved or explained. The authoress, guided by her own experience as a schoolmistress, is probably right in continually pointing out fresh phenomena of interest, which may or may not be immediately forgotten, rather than in wearying the child with difficult arguments which could at best be imperfectly understood, and which would be sure in many cases to awaken a feeling of disgust. In short, Sunshine is a kindergarten and not a school.

Simple and homely language is employed with the greatest propriety, but occasionally it tends to be vague or even to produce a wrong impression. One or two actual mistakes may be referred to in order that they may be corrected in a future edition.

Thus, it is stated that as a rainbow entirely vanishes when the sun is as much as 42° above the horizon, we can never see one at noon. "In the summer" should obviously be added. The reader is told to spin a top carrying a disk painted half yellow and half blue and he will see green. There is a confusion here between the colour obtained by adding two colours as by spinning, and that which is the result of mixing pigments. As is well known, green is not produced under these circumstances, but white or nearly white. The four chapters on soap bubbles, which contain much that is sure to please, are supplemented by some special instructions, which, however, are not quite correct. Fig. 167 is an illustration of an experiment purporting to measure the surface-tension of a soap bubble by the depression of the water level in a quill tube dipping into a glass of water. As the bubble is drawn much larger than the two hands, the pressure within it would not produce any depression of the water below the general level. It would not even visibly affect the capillary elevation. Then it is stated that the surface-tension of pure water is 16·62 grains per square inch. It is, as a fact, a little over three grains per linear inch. The confusion becomes greater in the passage, "We know exactly how much energy it (the elastic film of water) has—16·62 grains per square inch. A tube of 1-inch bore will lift up 16·62 grains of water."

There is one serious fault in the book. Serious because an experiment is described as though it were being performed to an audience which is not only impracticable and impossible, but which would require in a soap-film a property different in kind to that which it possesses. A school-slate frame with one end removed is hung up so that the remaining end is uppermost. A knitting-needle is cut of such a length that it will slide freely in the groove made to hold the slate. From the knitting-needle a pill-box is hung by threads. The object is to weigh a letter. A soap-film is spread over the frame as far as the knitting-needle.

"See how the film is stretching, the knitting-needle is bringing it down like a blind. Now we place a letter in the balance. I know that it weighs just half an ounce, so I can mark on the slate-frame with my blue pencil the place where the knitting-needle stops for half an ounce. I see I was not mistaken in what would take your fancy! I will hang it up here. You shall make one for yourselves, and spend what time you please with it. You will not then easily forget how elastic the film is."

Now the surface tension of a soap film is so small that if the knitting-needle and pill box weighed nothing the slate frame chosen must have been eight or nine feet across, and the knitting-needle the same length; or if the letter and the pill box weighed nothing the knitting needle, if of steel, must have been a great deal finer than any in ordinary use. But even if the experiment were being performed on a minor planet, instead of at Manchester, where with diminished gravitation the half-ounce knitting-needle and pill box would only just be sufficient to balance the tension of the soap film, the description would give the false impression that like a metal or other spring the tension of the soap film increases as the film is stretched, and so is able to rest steadily at some point which depends on the stretching weight. One obviously invented experiment described with all the circumstance and detail that this is, is sufficient to shake one's faith in the genuineness of other demonstrations.

C. V. B.

STRETTON ON THE LOCOMOTIVE.

The Locomotive Engine and its Development. By Clement E. Stretton, C.E. (London: Crosby Lockwood and Son, 1892.)

THE author of this work is well known to the railway world as one who has long taken a great interest in everything pertaining thereto. No one probably has a better knowledge of the history and development of the locomotive. It is with much pleasure we welcome the volume before us. The author very properly gives to Trevithick the name of "Father of the Locomotive," he having used high-pressure steam, the smooth rail, and the blast pipe, some years before either Hedley or Stephenson began to experiment. It is a pity so many men connected with the early progress of the locomotive should have been lost to fame; all did their share—the few only have been handed down to posterity. William James, for instance, certainly should not be forgotten, he having had a large share of the work in proving the locomotive to be a suitable machine for hauling trains, as against the system of fixed engines and rope haulage, and to him is largely due Stephenson's success on the Liverpool and Manchester Railway.

Richard Trevithick was born April 13, 1771, in the parish of Illogan in Cornwall. He was a mechanical genius in many ways. His first engine was made in the year 1803. This engine ran on four wheels, the boiler was arranged horizontally and had a wrought iron return fire-tube; the cylinder was 8¼ inches in diameter, and the piston had a stroke of 4 feet 6 inches. It was arranged horizontally, the crosshead driving a shaft in front of the boiler by means of a return connecting-rod. This shaft carried a heavy flywheel, and was connected to the carrying wheels of the engine by means of spur gearing. The exhaust steam was discharged into the chimney, ensuring an efficient supply of steam.

In the year 1808 Trevithick laid down a circular railway in a field which now forms the southern half of Euston Square. The locomotive exhibited had a vertical cylinder, the crosshead being coupled direct to the hind pair of wheels. This engine weighed about ten tons, and ran at an approximate speed of ten to twelve miles per hour. From these data it will be at once seen that Trevithick was before either Hedley or Stephenson with the invention of the locomotive engine, since both Hedley's and Stephenson's experiments date from the year 1813.

The volume under notice is full of historical data having reference to these early experiments. The author has taken great pains in arranging the matter. Further on in the book, chapter iii., another most interesting subject is dealt with. "The Battle of the Gauges" will long be remembered by engineers. The standard gauge of railways in this country is 4 feet 8½ inches, measured between the heads of the rails. This peculiar dimension appears to have been originally due to the tramways in use at the collieries where the original experiments were carried out by Stephenson and others, and was adopted for the railways when first projected and locomotives used. The great exception to this standard was the seven-feet gauge of the Great Western Railway. This railway, when projected by Mr. Brunel, was intended to eclipse the narrow-gauge of railways, both in speed and comfort when travelling. This competition, however, is claimed by the author as having been the means of hastening the growth and perfecting the locomotive. Looking at the question from the present day, the 4 feet 8½ inch, or standard gauge, is certainly too narrow; the power of the locomotive has gradually been increasing since Stephenson's day, and a point will soon be reached when radical changes must be made in locomotive design, in order to increase the power still more. On the other hand, the now obsolete seven-feet gauge of Brunel was too large. The Indian engineers have adopted the gauge of 5 feet 6 inches for the standard of that country. This dimension appears to be a "happy mean," and one with which locomotive engineers may revel in large journals and free steam and exhaust ports in locomotives fitted with inside cylinders.

It is amusing to read that American engines commenced their competition with the English engine in the year 1840, when some were imported to work the trains up the Lickey incline of one in thirty-seven on the Birmingham and Gloucester Railway. These engines were made by Messrs. Norris and Co., of Philadelphia, weighing slightly under eleven tons. The author tells us they thoroughly beat the English engine of that day doing this particular service.

Every locomotive engineer knows what the Stephenson link motion is—the apprentice in his first year generally prides himself on having mastered its details; yet, for all this, the author tells us to call this old friend by another name! It seems that this gear is really due to Mr. William Howe, an employé of Messrs. R. Stephenson and Co., and was adopted by them and first fitted to an engine for the North Midland Railway in the year 1842. It may here be noted that the question of valve gear generally is not sufficiently described or illustrated in this volume. The index contains several references, but these are very superficial. This becomes all the more apparent when the Joy valve gear is fully described and illustrated, besides a diagram showing results of working.

The Joy valve gear is in the opinion of many an unsuitable gear for a locomotive. It must be evident that any gear which derives its valve motions principally from the vertical movements of the connecting-rod cannot give a good distribution of steam, for the reason that the vertical movements of the connecting rod are affected by those of the driving-axle. The driving-axle is not always in the same position as regards the frames and cylinders owing to the undulations of the road, the oscillation of the engine, and the varying condition of the springs; a movement of half-an-inch above and below the normal position of the driving-axle is quite within the limits of actual practice. This movement is sufficient to affect the true movement of the valve; indeed, it is enough to destroy the lead either on the front or back ports as the case may be. Besides this objection, the Joy gear has nominally a uniform lead for all degrees of expansion, whereas it is usually considered necessary to increase the lead for higher grades of expansion and speed of engine. Some locomotive engineers are willing to risk this defective steam distribution in order to take advantage of the undoubted improvements in design the adoption of this valve gear allows. These mainly consist in the increase in length of the driving-axle bearings for engines with inside cylinders, there being no eccentrics to find room for between the crank webs. The cylinders can be consequently placed closer together, and the steam chest arranged either above or below the cylinders, as the case may be, without the use of rocking shafts or intermediate gear.

Chapter IV. deals with modern locomotives for main line trains. Many well-known engines are illustrated and described, and we naturally find the Compound Locomotives of Messrs. Worsdell and Webb included in the number. The author evidently is not enamoured with the compound locomotive, saying that "facts" are in favour of the simple engine. It is here to be noted that no locomotive superintendent in this country, excepting the patentees of the respective systems, has adopted the compound system. What this is due to is uncertain, because the two-cylinder type of compound locomotive known as the Worsdell system has certainly given good results in India and other countries, comparing favourably with the simple engine. The "Gladstone" locomotive, designed by the late Mr. William Stroudley, is among those illustrated. This raises the interesting question as to the wisdom of using large leading coupled wheels for express work; many engineers prefer a bogie in front, deeming it safer. But when the London and South Western Railway practically copy Mr. Stroudley's arrangement of wheels in their latest engines for mixed traffic, one is apt to be surprised at the change coming from the "bogie" head quarters, and to surmise that anything will do. There is, however, nothing new in the adoption of large leading coupled wheels; many engines were running in India of this design before Mr. Stroudley adopted it, and the whole question can be narrowed down to the comparative life of tyres under different types of engines; there can be no doubt that a four-wheeled bogie or a Bissel truck in front saves the tyres of the leading coupled wheels, a larger mileage being obtained from them before they require to be returned.

Chapter V. includes a description of the sand blast arrangement for sanding the rails to prevent the slipping of the driving wheels. This apparatus, small as it is, has left its mark on the design of express locomotives. The single engine has again come to the front for express work with marked success, the latest design of Midland and Caledonian engines being examples.

This volume taken as a whole is most interesting, and should be of value to all connected with the railway system of this country as a book of reference.

N. J. LOCKYER.

OUR BOOK SHELF.

Sketches of British Insects. By Rev. W. Houghton, M.A., F.L.S., M.S.L. (London: O. Newmann and Co., 1892.)

It is satisfactory to find that there is sufficient demand for elementary books on entomology to render necessary a new edition of Mr. Houghton's "Sketches of British Insects;" and for those who, as dwellers in the country, wish to gain some insight into the insect life around them few better books could be found. The differences between the several orders of insects and the main distinctions of the families are plainly and intelligibly set forth, though in a few instances the definition of terms and sections is somewhat faulty; thus, "Arthropod" would be more fitly translated "with jointed feet" instead of "with feet at the joints," and the numerous exceptions are not enough insisted on, there being for instance many insects with aquatic respiration and crustacea with aerial. In Lepidoptera the tongue is often completely absent, whilst in butterflies the forelegs are never wanting, as stated, though in certain families they are rudimentary in both sexes or in the male only, and again the two pairs of spurs on the hind tibiæ are present in the vast majority of moths and also in many skippers. The insects selected for description are well chosen, either as being conspicuous and typical of their families or as illustrating by their peculiarities some principle of adaptation to surroundings, though in many cases the classification is not according to modern ideas; thus, the clearwings (*Sesia*, &c.) have no affinities with the beehawks (*Hemaris*), which belong to the *Sphinges;* and the snouts (*Hypena*) are *Noctues* not *Pyrals.* The account in the Introduction of the structure and metamorphoses is especially simple and clear, and the small volume is on the whole an admirable sketch of British insect life, though the coloration of the plates might have been made much less crude without adding materially to the cost of production.

The Birds of Lancashire. By F. S. Mitchell. Second Edition. Revised and Annotated by Howard Saunders. (London: Gurney and Jackson, 1892.)

We are glad to welcome a new edition of this book, which we reviewed shortly after the publication of the first edition NATURE, vol. xxxii. p. 241). The task of preparing a new edition (in the absence of Mr. Mitchell from England) was undertaken by Mr. Howard Saunders, and it is scarcely necessary to say that he has discharged his duty thoroughly. He has no personal connection with Lancashire, but he has had much help from local authorities, especially from Mr. R. J. Howard, of Blackburn; and with their aid he has brought the book, as far practicable, up to date. Several species have been added to the list, and there is a new index.

Borneo: Its Geology and Mineral Resources. By Theodor Posewitz. Translated from the German by Frederick H. Hatch. (London: Edward Stanford, 1892.)

The original work, of which this is a translation, has been reviewed in NATURE (vol. xl. p. 49), so that it is unnecessary now to do more than record the fact that an English rendering of the book has been published. Dr. Hatch has done his work most conscientiously, and the translation is likely to be much appreciated by students of geology and mineralogy, and by all who have any reason for being specially interested in the material resources of Borneo.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

"A New Course of Chemical Instruction."

I am much interested in the article in NATURE for September 29, entitled "A New Course of Chemical Instruction," especially as the writer, in the criticism of the book in question, whilst thinking that the method there advocated has theoretically more to recommend it than any other, doubts whether practically the time required is not an insurmountable obstacle.

For four years I have been able to teach beginners in Chemistry on a method very closely allied to the one here proposed, that is to say, one in which no experiment is performed without a definite object in view—the final object being the solution of a given problem and no idea being given to the pupil of what the result will be, and I am glad to be able to say that the time required is *not* such a serious drawback as might be supposed, whilst the intense interest aroused and the training in scientific methods of work amply compensate for the slower acquirement of chemical facts.

I have not the advantage of being acquainted with Mr. Castell-Evans' book, so that I am not quite sure how nearly my work would agree with his course, but the fundamental principle is undoubtedly the same, and is the one laid down by Dr. Armstrong in the report of the British Association Committee on Chemical Teaching, where he advocates the teaching of Chemical method rather than Chemical facts.

What generally appals the beginner in Chemistry is the multitude of facts to be remembered; it seems a mere question of memory, and in consequence so dull and uninteresting, that the explosion or "burst up" is the one point to be looked forward to in the lesson. By this new method the pupils themselves are put into the position of discoverers, they know why they are at work, what it is they want to discover, and as one experiment after another adds a new link to the chain of evidence which is solving their problem, their interest grows so rapidly, that I have seen at a demonstration lesson a whole class rise to their feet with excitement when the final touch was being put to the problem which it had taken them three or four lessons to solve. Facts learned with so much interest are not forgotten and form a solid basis which it is true is slowly laid, especially at first, but it is interesting to see how much more quickly and easily later facts are assimilated, each one fitting itself in with the knowledge already acquired, and even when it becomes a question of reading the account of work which it is impossible for the student to repeat for himself, the methods adopted are quickly understood and easily remembered, because the general methods of analysis and synthesis have, in an easy form, not only been used, but discovered by the student himself.

This method of course breaks down where an elaborate examination syllabus is imposed upon the beginner from the outset, and even where this is not the case, every teacher must adapt the method to his own conditions, only and always keeping the fundamental principle in view.

For the beginner in Chemistry whether he is later to specialise in this subject or not, experience has convinced me that the teaching of facts must give way to the teaching of method if a sound basis is to be laid in chemical science, whilst the subject opens the whole question of the value of Chemistry teaching from the educational point of view. GRACE HEATH.

The Temperature of the Human Body.

THERE is a problem partly physiological and partly physical which I shall be grateful if any reader of NATURE can throw light upon.

1. *The physiological.*—I am assured by medical opinion in which I have confidence that the temperature of the human body is invariable from pole to equator of the earth. The question I want to ask, assuming this to be true, is this: What is the action in the body which exactly and everywhere counterbalances the radiation and conduction of heat in the one case from the body and in the other to the body? I thought at first that perspiration might have something to do with it, but my medical authority assures me that at the equator a man who perspires freely has exactly the same temperature as one that perspires little, although the former will be in good and the latter in bad health.

2. *The physical.*—Treating the animal as a heat engine, one is apt to think of the source of heat as the animal heat engendered by the combustion going on in his frame, and the refrigerator as the surrounding air at lower temperature—in the experience of most of us. The animal then does work at the expense of this heat during its transfer from source to refrigerator, as in an ordinary engine. On the other hand, the animal in equatorial regions must, if the physiological statement above be a fact, be often the coldest of surrounding bodies. Does he also do work at the expense of the heat of combustion in his body, and if so is this vital action an exception to the second law of thermodynamics? If not, does he do work at the expense of the heat which is conducted into his body from hotter surrounding bodies, which heat, when he is doing no external work, still does not raise the temperature of his body?

Rugby. L. CUMMING.

Comet II. 1892 (Denning, March 18).

THIS comet is still a tolerably easy object in my 10-inch reflector and will doubtless continue to be visible during the greater part of the ensuing winter. It is now approaching the earth, and its brightness is increasing slightly. During the next two months it will traverse Orion.

I observed the comet on September 30, when it was in the same field as the 6th mag. star Piazzi VI. 144 (Lalande, 12546). By differential observations with that star I found the place of the comet to be

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The theoretical brightness, as given in Schorr's ephemeris, was 0·62, but to my eye the comet seemed quite as plain as in March last. The nucleus was, perhaps, not so distinct, but the surrounding nebulosity appeared to be more extended than on previous occasions.

The comet will be close to ζ Orionis (the southernmost star in the belt) about November 14, and passes very near β Orionis (Rigel) on November 30. W. F. DENNING.

Bristol, October 2.

Cirro-stratus.

A RATHER perfect example of one variety of this cloud was seen here in the afternoon of September 27. A rapid fall of the barometer until 5 A.M., accompanied by a high wind, had been followed by a steady rise, the wind moderating some hours later. At 2 p.m., with a westerly light air, the sheet of cirro-stratus which overspread the sky appeared in the form of a series of very perfect undulations, stretching nearly north and south. These were about fourteen in number, crowded together towards the east. The lower surface of the sheet was sharply defined, and could be followed with ease in its successive rise and fall. The cloud-filaments could be also traced, preserving their perpendicularity to the wave-fronts and conforming to the undulations of the lower surface with a closeness which I had not before observed, although sheets of cirro-stratus are common here. The whole system was drifting slowly to the east.

J. PORTER.

Crawford Observatory, Queen's College, Cork.

A New Habitat for Cladonema.

WILL you kindly allow me through your columns to note a habitat for this genus not given in Allman or Hincks. Several weeks ago I received some sponge from Mr. Sinel, of Jersey, and on examining it with a hand-lens detected four polypites of Cladonema, one, at least, of which is still alive.

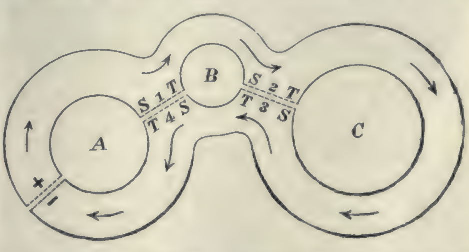
HENRY SCHERREN.

5 Osborne Road, Stroud Green, N.

TO DRAW A MERCATOR CHART ON ONE SHEET REPRESENTING THE WHOLE OF ANY COMPLEXLY CONTINUOUS CLOSED SURFACE.

IF a solid is not pierced by any perforation, its surface is called simply continuous, however complicated its shape may be. If a solid has one or more perforations, or tunnels,[1] its whole bounding surface is called "complexly continuous"; duplexly when these is only one perforation; $(n+1)$-plexly when there are n perforations. The whole surface of a group of n anchor-rings (or "toroids") cemented together in any relative positions is a convenient and easily understood type of an $(n+1)$-plexly continuous closed surface.

Let the diagram represent a quadruplexly continuous closed surface made of very thin sheet metal, uniform as to thickness and homogeneous as to quality throughout. To prepare for making a Mercator chart of it, cut it open between perforations C and B, B and A, A and outer space, in the manner indicated at $\overset{2}{\underset{3}{=}}$, $\overset{1}{\underset{4}{=}}$, and ±. Apply infinitely conductive borders to the two lips separated by the cut at ±, and apply the electrodes of a voltaic battery to these borders. By aid of movable electrodes of a voltmeter trace, on the metallic surface, and a very large number $(n-1$, of equidifferent equipotential closed curves between the + and − borders. Divide any one of these equipotentials[2] into parts each equal to the



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[1] A "hole" may mean a deep hollow, *not* through with two open ends. The word "tunnel" is inappropriate for the aperture of an anchor ring. Neither "hole" nor "tunnel" being unexceptionally available, I am compelled to use the longer word "perforation."

[2] Two sentences of my previous article ("Generalisation of Mercator's Projection") in § 3, and in last paragraph but one, are manifestly wrong, and must be corrected to agree with the rule given for dividing into infinitesimal squares, in the present text.

infinitesimal distance perpendicularly across it to the next equipotential on either side of it; and through the divisional points draw curves, cutting the equipotentials at right angles. These curves are the stream lines. They and the $(n+1)$ closed equipotentials (including the infinitely conductive borders) divide the whole surface into $n\ m$ infinitesimal squares, if m be the number of divisions which we found in the equipotential. The arrows on the diagram show the general direction of the electric current in different parts of the complex circuit; each arrow representing it for the thin metal shell on either far or near side of the ideal section by the paper.

Considering carefully the stream-lines in the neighbourhoods of the four open lips marked in order of the stream 1, 2, 3, 4, we see that for each of these lips there is one stream-line which strikes it perpendicularly on one side and leaves it perpendicularly on the other, and which I call the flux-shed-line (or, for brevity, the flux-shed) for the lip to which it belongs. The stream-lines infinitely near to the flux-shed, on its two sides, pass infinitely close round the two sides of the lip, and come in infinitely near to the continuation of the flux-shed on its two sides. Let F_1, F_2, F_3, F_4 (not shown on the diagram) be the points on the + terminal lip from which the flux-sheds of the lips 1, 2, 3, 4 proceed; and let G_1, G_2, G_3, G_4, be the points at which they fall on the − lip. Let S_1, T_1, S_2, T_2, &c., denote the points on the four lips at which they are struck and left by their flux-shed-lines.

Let p_1, l_1, p_2, l_2, p_3, l_3, p_4, l_4, p_5 be the differences of potential from the + lip to S_1, from S_1, to T_1, T_1 to S_2, ... S_4 to T_4, and T_4 to the − lip. Measure these nine differences of potential. We are now ready to make the Mercator chart. We might indeed have done so without these elaborate considerations and measurements, simply by following the rule of my previous article; but the chart so obtained would have infinite contraction at eight points, the points corresponding to S_1, T_1, ... S_4, T_4. This fault is avoided, and a finite chart showing the whole surface on a finite scale in every part is obtained by the following process.

Take a long cylindric tube of thin sheet metal, of the same thickness and conductivity as that of our original surface; and on any circle H round it, mark four points, h_1, h_2, h_3, h_4, at consecutive distances along its circumference proportional respectively to the numbers of the m stream-lines which we find between F_1 and F_2, F_2 and F_3, F_3 and F_4, F_4 and F_1 on the + lip of our original surface. Through h_1, h_2, h_3, h_4 draw lines parallel to the axis of the cylinder.

Let now an electric current equal to the total current which we had from the + lip to the − lip through the original surface be maintained through our present cylinder by a voltaic battery with electrodes applied to places on the cylinder very far distant on the two sides of the circle H. Mark on the cylinder eight circles, K_1, K_2... K_8, at distances consecutively proportional to l_1, p_2, l_2, p_3, l_3, p_4, l_4, and absolutely such that l_1, p_1, &c., are equal to the differences of their potentials from one another in order.

Bore four small holes in the metal between the circles K_1 and K_2, K_3 and K_4, K_5 and K_6, K_7 and K_8 on the parallel straight lines through h_1, h_2, h_3, h_4, respectively. Enlarge these holes and alter their positions, so that the altered stream-lines through h_1, h_2, h_3, h_4 (these points supposed fixed and very distant) shall still be their flux-sheds. While always maintaining this condition, enlarge the holes and alter their positions until the extreme differences of potential in their lips become l_1, l_2, l_3, l_4, and the differences of potential between the lips in succession become p_2, p_3, p_4. In thus continuously changing the holes we might change their shapes arbitrarily; but to fix our ideas, we may suppose them to be always made circular. This makes the problem determinate, except the distance from the circle H of the hole nearest to it, which may be anything we pleased, provided it is very large in proportion to the diameter of the cylinder.

The determinate problem thus proposed is clearly possible, and the solution is clearly unique. It is of a highly transcendental character, viewed as a problem for mathemetical analysis; but an obvious method of "trial and error" gives its solution by electric measurement, with quite a moderate amount of labour if moderate accuracy suffices.

When the holes have been finally adjusted to fulfil our conditions, draw by aid of the voltmeter and movable electrodes, the equipotentials, for p_1 above the greatest potential of lip 1, and for p_5 below the least potential of lip 4; and between these equipotentials, which we shall call f and g, draw n-1 equidifferent equipotentials. Draw the stream-lines, making infinitesimal squares with these according to the rule given above in the present article. It will be found that the number of the stream-lines is m, the same as on our original surface, and the whole number of infinitesimal squares on the cylinder between f and g is $m\ n$. Cut the cylinder through at f and g; cut it open by any stream-line from f to g, and open it out flat. We thus have a Mercator chart bounded by four curves cutting one another at right angles, and divided into $m\ n$ infinitesimal squares, corresponding individually to the $m\ n$ squares into which we divided the original surface by our first electric process. In this chart there are four circular blanks corresponding to the lips 1, 2, 3, 4 of our diagram; and there is exact correspondence of their flux-sheds and neighbouring stream-lines, and of the disturbances, which they produce in the equipotentials, with the analogous features at the lips of the original surface as cut for our process. The solution of this geometrical problem was a necessity for the dynamical problem with which I have been occupied, and this is my excuse for working it out; though it might be considered as devoid of interest in itself.

KELVIN.

THE RECENT ERUPTION OF ETNA.[1]

THE southern flank of Etna has been the site of three consecutive eruptions, remarkable for the diversity of the phenomena they presented.

On March 22, 1883, after several violent shocks of earthquake, the ground was rent open in a N.E. and S.W. direction, almost on the continuation of the big rift formed in the eruption of 1879, and near Monte Concilio a most interesting eruptive apparatus was formed. Very quickly, however, the eruption was arrested, but the eruptive energy had not had sufficient vent, as evidence of which were the frequent shocks which followed it and persisted, until on March 18, 1886, the ground was again split open as a prolongation of the rift of 1883, giving rise to an imposing eruption, during which an enormous quantity of lava was poured forth. This eruption from the very beginning manifested a great explosive force. The fragmentary materials were projected to an extraordinary height from several craterets formed along the rift, most of which, however, soon became quiet and were buried by the ejectamenta of the others, remaining alone the one twin crater now called Monte Gemmellaro. After this eruption the geodynamic phenomena and the volcanic activity at the central crater remained exceedingly feeble up to the last few days, so that this actual eruption did not present any grand display of premonitory phenomena.

On the evening of July 8, at about 10.30, the central crater of Etna began to send up a dense column of vapour, charged with dust, lapilli, and large rock fragments, which rose as an imposing mass with the characteristic pine-shape of explosive eruptions, and illuminated by lightnings.

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[1] This paper was written in Italian, and sent as a letter to Dr. H. J. Johnston-Lavis, who has kindly translated it for NATURE, as requested by the author.

After half an hour this phenomenon ceased, and the smoke-plume was swept away by the higher currents of the atmosphere. I was able to ascertain in my excursion to the summit of Etna, in company with Mr. Rudler, curator of the Museum of Practical Geology of London, that the central crater was much modified by the short eruption. It presented two mouths, separated by a partition, whilst its upper edge was much broken down, so that it was enlarged. The ejected materials were composed of fragments of very much altered lavas that fell chiefly to the westward. During the night the ground was in a state of tremor, and at 2.45 a.m. of the 9th, a strong shock of earthquake was felt all over the Etnean region, producing slight damage to the walls of buildings.

Towards 1.20 p.m., without any further shock sensible in the inhabited regions, the southern flank of Etna was rent open, and I could observe from Acireale a dense curtain of smoke rush up in great vortices, accompanied by continual rumblings. Towards evening one could see that the lava had advanced very rapidly in a southern direction. At the upper part it was observable that several jets, arranged in a linear manner, of fragmentary materials were being shot up to a great height, especially at three main points on the new and great rift. The explosive force of this eruption was much less than that of the eruption of 1886, in which the fragmentary ejecta were shot up to a height of 1200 metres, whilst in the present case the height rarely exceeded 500 metres. This fact depends on the great altitude and the great size of the new fissure, which afforded a free escape for the energy of the volcano, and gave forth a much greater quantity of lava. The lava in less than three days travelled more than four kilometres, and having surrounded Monte Nero, which is to the south of the new craters, it divided in two principal branches and precipitated itself on the plain from which rises Monte Gemmellaro, forming three cascades of living fire. It here spread out, and the two branches, directing their course to the south, threatened Nicolosi, Belpasso, and Pedara. The more eastern ramification, when it reached the neighbourhood of Monte Albano, began to slow down and was already on the 12th advancing about two metres per hour, but increasing the breadth of its front and its thickness. On the other hand the western branch, which was invading the cultivated land, advanced in the steeper ground over fifty metres the hour, as I observed in my first visit on July 11. This stream was of a bright red colour, slightly covered by scoria. Near Monte Concilio it had filled up a valley, assuming a thickness of over 40 m. From Monte Ardicazzi we had presented to our view an immense expanse of fire from which rose crests and hills all incandescent, divided by deep depressions. It appeared like the sea in a tempest, the waves of which in their fury were suddenly petrified. From the crests were constantly being detached fresh incandescent masses which rolled down and choked the depressions, whilst new gushes raised the masses of scoria into new hills of fire. Amidst the phonolitic noise of the lava in movement, I noticed gigantic puffings produced by the escape of the vapour of H_2O, which, accumulating amidst the mass of the lava, formed gigantic bubbles which rose and burst, allowing the escape of the compressed gas.

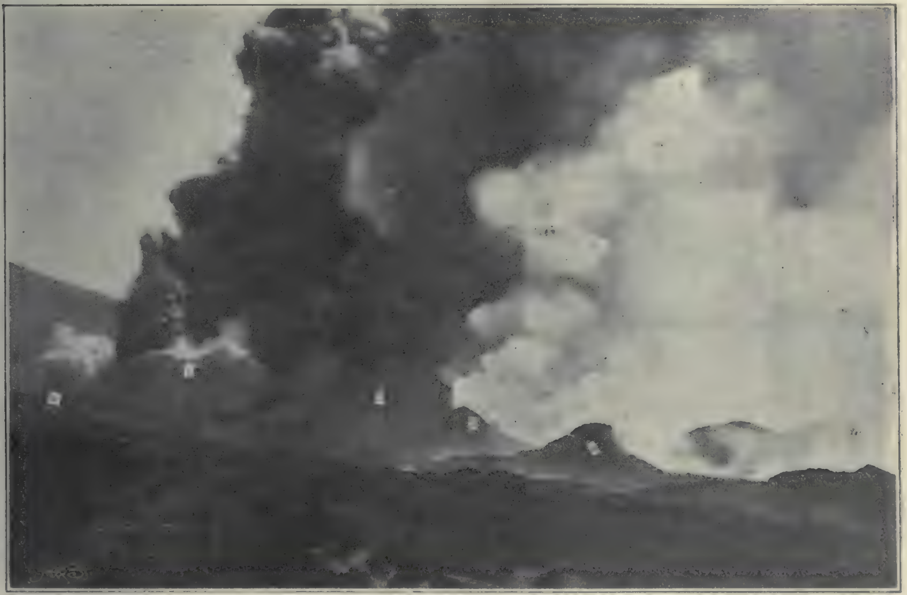

Fig. 1.—Taken by Sig. Ledrù on July 17. (No. 1, 2) are craters No. 1 and 2. (No. 3 and 4) craters No. 3 and 4 in process of formation.—(*m*) Crater orm vent at the north base of crater No. 1.—(*a*) Monte Nero about one km. west of the craters.

The eruption was very active during the following days with short intervals of diminution or marked increase. Remarkable phenomena were the blasts which shook the doors and windows at Nicolosi, Acireale, and Catania, and, at localities nearer the point of eruption, even the walls.

On July 16 I started again, with my brother Giovanni, to approach the site of eruption. From Monte Caprioletto, which is about 1200 m. distant, we could observe not only the three principal craters above mentioned, but also two others lower down, which so far had not grown to any important size.

Approaching still farther, we stopped at about 300 m. off on the west, on a plain upon which grows the *Astragalus Siculus*, the bushes of which are now covered by large lapilli, and in part are burnt. The crater, which for brevity we will call No. 1, gave forth large and continual bursts of dust and scoria from its summit, and also from other points on its northern wall, at the base of which issued a jet of light-grey vapour, which came from a little imbutiform crater separated from the main one by a partition of small size; from this were ejected a little dust and occasionally stones. The explosions of No. 1 were not accompanied by loud noises (*boati*, *bellowings*), but by strong and continual roarings like the sea in a tempest. Crater No. 2, more regular in form, gave forth frequent eruptions of dust, with many incandescent projectiles. In the moments of calm between one explosion and another, a slight white vapour escaped. The first burst of the explosion might be compared to a gigantic pointed jet preceded by black dust and sand, which rose with great rapidity in consequence of the great ascensional velocity, which was gradually impeded by the resistance of the air; then the column of black smoke charged with dust began to open out the immense vortices of compressed vapour which, always rising, assumed an imposing and characteristic aspect. The pieces of scoria were followed by a trail of dust both in their rise and fall, and when they struck the flanks of the mountain as they rolled down, they raised a cloud of dust and gave forth a characteristic sound. When they were numerous the mountain became all covered by a yellow dust.

Also in this last crater the explosions took place from several points of its funnel-shaped cavity; and we saw, at about mid-day of the 17th, much of its southern side destroyed by several bursts that took place from that point.

Both of these craters, already of considerable height, had an elliptical base, and specially No. 1, the maximum diameter of which is in the direction of the great rift, along which they are distributed.

The third crater, which we will call No. 3, adjoining the preceding one, presents a large depression to the south. It gave forth frequent bursts of incandescent lava fragments, with a constant noise resembling the constant discharge of much musketry, and accompanied by yellowish-white vapours. The emission of dust was rare, and only occurred when the eruptive bursts scored the north side of the crater. The fragments of incandescent lava, which in this crater were not accompanied by a trail of dust, often were torn asunder in the air, being reduced to fragments.

The discharge of smoke from this crater occurred from the highest part, then there was the point at which occurred the numerous explosions of lava, then another jet of smoke, in its turn followed by another point lower down, from which occurred the explosions of the incandescent projectiles that gradually formed a crater, which we will distinguish as No. 4.

In general, while we were moving about to the westward of the craters on the morning of the 17th, the eruption was exhibiting comparatively little energy. Gradually, however, the explosions increased in violence, and the ejecta became more numerous. It is worthy of notice that the smoke, according to the place whence it issued was white, blue, light or dark grey, black, yellow, and even iridescent. Approaching nearer the craters, we attempted to encircle them on the north, when we found numerous

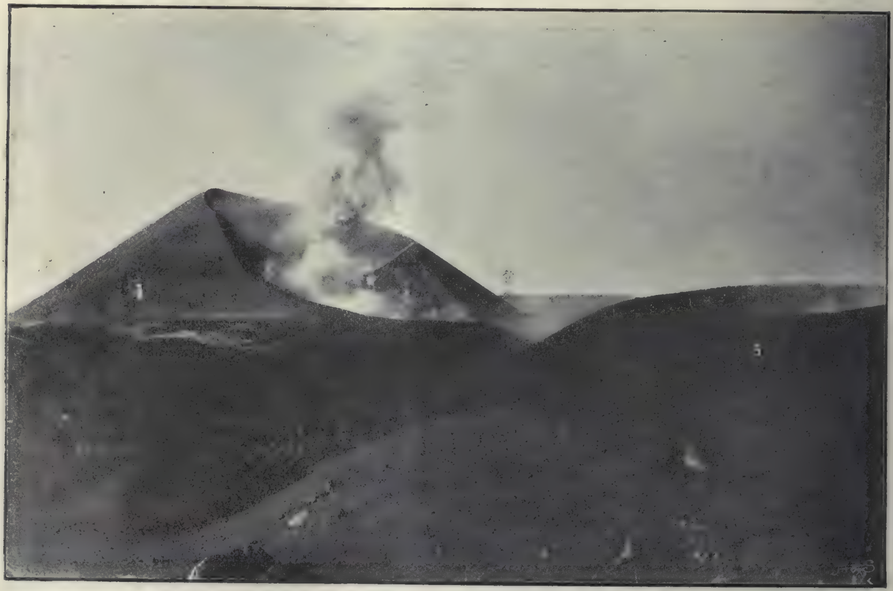

FIG. 2.—By Sig. Ledrù on August 19, at 100 m. to the north-east of the craters. (*S*) Crater of August 11. (*d*) Crater to the west which was in activity only on July 9. (1) Crater No. 1.

little fissures in the ground in a direction approximately parallel to that of the main rift. These, often over a metre in breadth, are choked by the loose materials forming the surface, and in part obstructed by the loose materials forming their sides. Higher up we found a wide cleft, which, starting from a higher point, was prolonged downwards towards the craters and was lost beneath the lava. Upon this fissure were arranged a series of crateriform elevations, some of which were extinct, and others still presenting a little solfataric action. On July 9, at the commencement of the eruption, lava and fragmentary ejecta also issued by this cleft, but it seems, the same day, to have become obstructed, and the tongue of lava which menaced the Casa del Bosco stopped, and the eruptive phenomena were diverted to the other more eastern fissure.

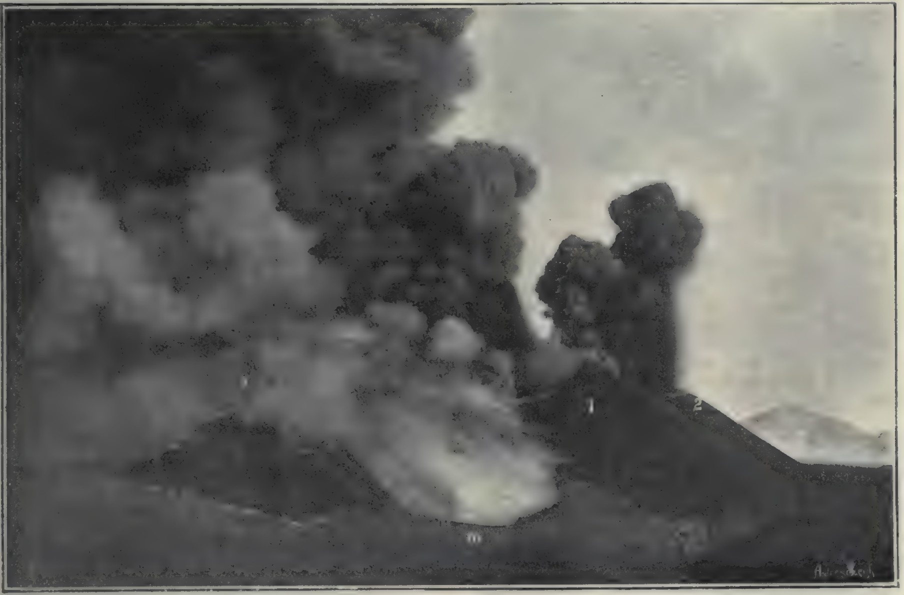

Fig. 3.—Taken by Sig. Modò on July 13, 1892, at 150 m. to the north-west of the craters. Craters No. 1 and 2. (*a*) Monte Nero. (*m*) Little northern crater.

It is absolutely impossible to accept the statement that this cleft represents the fire vents of the eruption of 1766, and that the solfataric phenomena which the cleft now exhibits are only due to the near vicinity of the new volcanic outlet, for—putting aside the fact that in visits anterior to the present eruption I had never found any sign of such, and this is confirmed by people accustomed to the locality—it is easy also to be convinced from the nature of the materials composing these craterets. These materials are so new as to leave no doubt as to their origin, and consist, those higher up, specially of blocks of old lava torn from the sides of the cleft; lower down they are principally scoria and other loose materials of recent formation.

Approaching still nearer, we were able to distinguish clearly that amongst the ejected materials of No. 1, besides the number of fragments of molten lava, there are often blocks of a dark grey colour that were already consolidated before their final ejection, which are either projectiles that have fallen back in the crater and have been re-ejected, or are pieces of rock detached from the walls of the volcanic chimney. Certainly from the last source are derived quartzites, which we collected amongst the ejected materials from this crater. This quartzite is semi-vitreous, very similar to that which we collected from the craters of the eruptions of 1883 and 1886. These facts evidently showed that all these three eruptions have traversed similar strata and that all have arisen over the same principal cleft. In fact the new eruptive apparatus formed at the base of the Montagnola about 1900 m. above sea level, lies on the northern prolongation of the rift of 1886, in a plain gently inclined toward the south, and which towards the east presents a marked slope, so that the new craters are much higher on their eastern side. In the great paroxysmal eruptions, and when a large rift opens at the surface of the earth, it is generally the rule that the eruptive mouth from which the lava flows without much explosive force is situated at its lowest extremity. The higher one goes along the fissure the less is the amount of lava that issues, but the greater is the explosive action, which higher still itself in turn diminishes. In the present eruption we have good examples of this. In fact, the small northern crater gave forth only dust, and very few fragments of new lava, and with little energy. No. 1 crater emitted much dust and also much lava; No. 2 more lava than dust, and Nos. 3 and 4 exclusively lava. The materials of the little northern crater (Fig. 3) are for the most part fragments of ancient lava, which lose their predominance in crater No. 1, and gradually disappear as one descends lower and lower. At the same time, as the old lava has a light bluish-grey colour and the fragments of the newer lava are much darker, the different craters exhibit different colours. This difference also depends in part upon the degree of fineness of the materials that compose the craters. In fact the northernmost crater at the beginning of the rift had not sufficient power to eject large materials, but lifted them up and kept them in continual movement, reducing them to fine dust, which was easily carried out by the vapour. No. 3, on the contrary, continually ejected large lumps of lava, often shooting them a considerable distance, whilst Nos. 1 and 2 exhibited intermediate stages, quite confirming what has been said above.

Whilst we were there the eruption increased little by little. The ground commenced to vibrate, and at 3.47 p.m. we felt a strong earthquake shock, followed by other frequent oscillations of the ground of less intensity but often very perceptible. In this new period of great activity general to all the craters the phenomena exhibited by No. 2 were worthy of remark. It no longer ejected dust, but pieces of hot lava with stronger explosions, which were more frequent but of shorter duration. Between one explosion and another there was slow evolution of white vapour, similar to that which rises from the fire-mouths and surface of the running lava. This floated above the crater, slightly disturbed by the wind, and when an explosion occurred it assumed a curious vibratory movement, rising a little, and then rapidly descending; then immediately was seen the first jet of solid materials, which, in its vertiginous upward course by vortex movement, sucked in the air over the crater edge, and the white vapours were drawn down, so looking as if they were being reabsorbed. This phenomenon, which attracted our attention when I was with you on Stromboli and the members of the Geologists' Association,[1] would show that within crater No. 2 there is pasty lava, which is pushed up by the vapour in it; then the magma swells up, bursts, and the lava falls.[2]

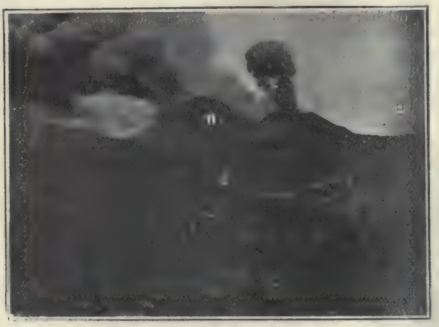

FIG. 4.—Taken by Sig. Modò on July 18, 1892, at 300 m. to the north-west of the craters. (1 and 2) craters No. 1 and 2. (*a*) Monte Nero. (*d*) Craters to the west which were in activity only on July 9.

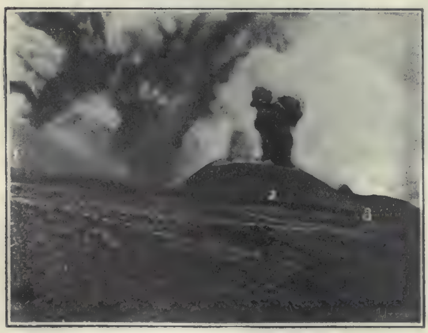

FIG. 5.—Taken by Prof. Riccò on July 20, west of the craters. (1, 2, 3), craters No. 1, 2, and 3.

In this parasitic crater of Etna, however, the phenomena were on a much larger scale, as also were the smoke vortex rings which we looked down upon when we were together at Stromboli. Likewise the explosions were far louder, reverberating as a low-pitched roar by the echo of the valleys, and they were audible in all the Etnean region, at Catania, Acireale, Giarre, and farther still for some dozens of kilometres from the craters. The air-shocks that accompanied these reports were very interesting. They represented a large undulation of the air, spreading with great velocity, reaching great distances, and contemporaneous with the audible vibrations.[3] While there, we felt the blow on our bodies, and especially our chests and in the ears; at the Casa del Bosco we detected the shock against the walls, which trembled, and farther off at Catania and Acireale we heard the rattling of the windows and doors, which, strongly shaken,

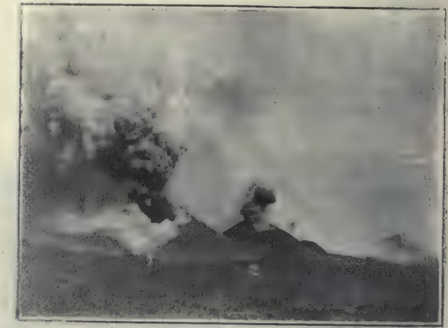

FIG. 6.—Taken by Prof. Riccò on July 20, to the north-west of the crater No. 1, 2, and 3. (*a*) Monte Nero.

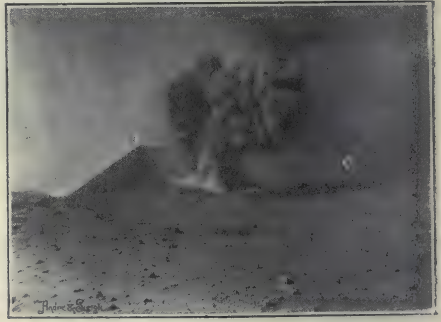

FIG. 7.—Taken by G. Platania from the north-north-east of the craters, July 30, 1892. (1) Crater No. 1. (*c*) Craters which were in activity only on July 9. The craters No. 2, 3, and 4 are hidden behind crater No. 1.

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[1] G. Platania "Stromboli e Vulcano, nel Settembre del 1889. Riposto 1889." This phenomenon I have often observed at Vesuvius, and I quite agree with Signor Platania as to its cause, as I have been able to look into the crater and watch the whole process.—Johnston-Lavis.

[2] The lava in this case is very like the boiling up of a viscous liquid in a long test-tube.—Johnston-Lavis.

[3] I have some doubts about the two mechanical disturbances travelling exactly at the same rate. When blasts are fired in a long tunnel the air-stroke is felt before the sound.—Johnston-Lavis.

give the impression of an earthquake, so that several times the people of these towns have rushed out into the streets. On July 14 I observed in Acireale that the large undulations of the air-blows which were propagated beyond 333 m. per second, like sonorous vibrations, often arrived unaccompanied by noise, and strongly shook doors and windows.

These reports, these air-blows, and the abundant ejection of incandescent lava still further prove that in No. 2 crater there was pasty lava which swelled and burst, as we deduced from its effect on the white vapours.

This period of great activity, in which the thick shower of lava fragments projected from the different craters to great heights, and spread over an area of 500m radius, reached its maximum about midnight, and then gently declined a little. In the same manner the eruption continued during the following days with great energy, but with a very gradual diminution in its intensity, interrupted more or less by strong spasms. The lava continued to advance, but diminished in velocity, while it extended in breadth and depth. The eastern branch very soon stopped, and also the western one, after having continued its destruction of very fertile ground. This having crossed the road known as the St. Leo, finally stopped, whilst the new lava that continues to issue forms new ramifications and flows, which pass quite close to the earlier ones, and now actually are in contact with them, increasing the area covered. In the first paroxysm of the eruption the lava issued in great gushes all along the rift. Soon at the upper part commenced the dejection cones, and lower down the fire vents, and the lava flowed in abundance, and with explosions also in points where now are the craters, as, for example, Nos. 3 and 4. Later, when the explosive force had diminished, the lava issued without explosions, almost silently from different vents at the south end of the fissure on which are aligned the craters. These vents, therefore, have during the eruption varied in number and form. Some have assumed the function of dejection craters as occurred in Nos. 3 and 4, which gave passage to much lava as a current. Others have ceased to eject scoria, to send forth only torrents of lava, as, for example, the little mouth to the east of No. 4, the scoria rim of which exists only to the north, of about 20m. high, whilst the south rim has been swept away by the current. Some of the mouths have been refilled by the lava flows, and whilst some have become extinct new ones have been formed.

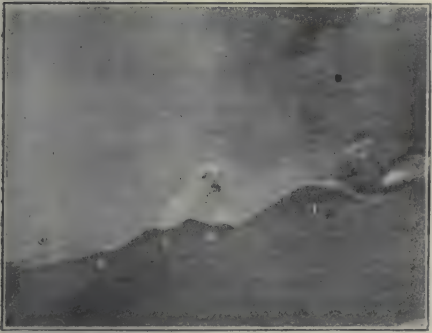

FIG. 8.—Taken by G. Platania on July 30 from the north-east of the craters, No. 4 is still very little, but in part hidden behind a prominence of the ground.

In the last week of July, crater No. 2 assumed, for some days, a new phase. Its explosions had become rare, long, and very grand, and the large mass of vapour, mixed with dust, brought back to my mind the eruption of Vulcano when we stood on the crater edge and watched and photographed the whole process, and stood our ground amidst showers of bombs and other projectiles (1888–90).[1] By this it lost the beautiful regular truncated cone form that it had at the beginning, and became irregular and broken-down towards the north, like No. 1.

At the commencement of August the eruption already seemed much diminished, craters No. 1 and 2 had ceased to eject stones little by little, gradually becoming blocked, and the enclosed lava was slowly cooling. In fact, on the recommencement of a period of renewed energy, the explosive force could no longer find an escape by them, so that on August 1 a new crater opened in a point higher up where the cleft to the west, which had only acted at the commencement of the eruption, joined another great rift on which the craters were formed. Then on August 9 occurred another violent eruptive spasm, which could not clear away the material that obstructed the craters, but opened a new way, always on the main cleft, between Nos. 1 and 2, and exactly at the north base of the last of these craters. Here a little funnel-shaped depression was formed which for a short time ejected enormous masses. This new crater, however, soon passed into the solfataric stage as Nos. 1, 2, and 3, and there remained in an energetic state of activity only the crater of August 11 and No. 4. That one which on August 21 measured in diameter only about 50 m., and had a height of about 60 m., later became elongated towards the S.S.W., and its grand and beautiful explosions, which I watched quite closely, in company with Mr. Rudler, on August 29, 30, and 31, were specially localized on the southern edge, so that they tended all the more to give it an elongated form on that more western cleft that was only in activity the first days of the eruption. No. 4, meanwhile, which I approached, ascending upon No. 3, gave forth frequent eruptions of hot lava cakes at regular intervals (about fifty per minute), accompanied by globes of yellowish vapour, and a noise similar to that which accompanies the globes of vapour from the locomotive when it commences to move.

By unanimous consent of all the studious inhabitants of Etna, the new craters have been called the Monti Silvestri, in honour of that well-known vulcanologist, the lamented Prof. Orazio Silvestri, who studied our volcano with so much fervour, registered so assiduously every slight disturbance, and described its paroxysms so well and with such originality, that his loss has been deeply felt by all men of science. GAETANO PLATANIA.

14, Via S. Giuseppe, Acireale,
September 7.

NOTES.

THE Harveian oration will be delivered by Dr. J. H. Bridges at the Royal College of Physicians on Tuesday, October 18, at four o'clock.

THE Medical Session in London was opened on Monday, and introductory addresses were delivered in some of the schools attached to hospitals. A particularly interesting and suggestive address was delivered at the Westminster Hospital by Dr. Mercier, who dealt with various aspects of the problems connected with crime, pauperism, and insanity. Sir John Lubbock addressed the students at St. Thomas's Hospital.

ON Friday last Sir George Murray Humphry, F.R.S., delivered an interesting address at the opening of the first session of the Queen's Faculty of Medicine in connection with Mason College, Birmingham. The union of the two institutions is likely to be of great service both to medicine and to pure science in the Midlands.

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[1] "South Italian Volcanoes," by Johnston-Lavis, Naples, 1891. "I Proettili Squarciati di Vulcano," by G. Platania. (Roma, 1891.)

A MARINE biological station has been established at Bergen, in Norway, the funds having been raised by private donations and by subscriptions from learned societies. It will be under the control of Dr. J. Brunchorst, and will supply ten places for Norwegian and foreign workers.

WE regret to learn that M. Henri Douliot, who had been commissioned by the French government with a botanical expedition to the western coast of Madagascar, has died there of fever.

DR. B. L. ROBINSON has been appointed Curator of the Herbarium of Harvard University, Cambridge, U.S.A., in succession to the late Prof. Serreno Watson.

MR. WALTER E. COLLINGE, late Assistant-Demonstrator in Zoology in St. Andrew's University, has been appointed to the vacant Demonstratorship in Zoology and Comparative Anatomy and Botany in Mason College, Birmingham.

A CIRCULAR appeal, dated September, 1892, and signed by Mr. E. C. Pickering, Director of the Observatory of Harvard College, has been issued, inviting the wealthy to consider the opportunity offered for a donor of 200,000 dollars "to have his name permanently attached to a refracting telescope, which, besides being the largest in the world, would be more favourably situated than almost any other, and would have a field of work comparatively new." The telescope in question would be placed in the station established by Harvard College Observatory, near Arequipa in Peru, at an altitude of more than eight thousand feet. "During a large part of the year," says Mr. Pickering, "the sky of Arequipa is nearly cloudless. A telescope station having an aperture of thirteen inches has been erected there, and has shown a remarkable degree of steadiness in the atmosphere. Night after night atmospheric conditions prevail which occur only at rare intervals, if ever, in Cambridge. Several of the diffraction rings surrounding the brighter stars are visible, close doubles in which the components are much less than a second apart are readily separated, and powers can be constantly employed which are so high as to be almost useless in Cambridge. In many researches the gain is as great as if the aperture of the instrument was doubled. Another important advantage of this station is that, as it is sixteen degrees south of the equator, the southern stars are all visible." The circular continues: "The planet Mars, when nearest the earth, is always far south. The study of the surface of this and of the other planets is greatly impeded by the unsteadiness of the air at most of the existing observatories. Even under the most favourable circumstances startling discoveries—relating, for example, to the existence of inhabitants in the planets—are not to be expected. Still, it is believed that in no other way are we so likely to add to our knowledge of planetary detail as by the plan here proposed." We venture to hope that the wealthy donor for whom Harvard is looking will soon be found.

BARON LÉON DE LENVAL, of Nice, offers a prize of 3,000 francs to the inventor of the best application of the principles of the microphone in the construction of a portable apparatus for the improvement of hearing in deaf persons. Instruments for competition should be sent to Prof. Adam Politzer, or Prof. Victor von Lang, Vienna, before December 31, 1892. The prize will be awarded at the Fifth International Otological Congress at Florence in September, 1893. If no instrument is judged worthy of the prize, the jury reserve the right of announcing another competition, unless Baron Lenval decides to dispose of the prize otherwise. The following are the members of the jury:—Prof. Adam Politzer (President), and Prof. Victor v. Lang, Vienna; Dr. Benni, Warsaw; Dr. Gellé, Paris; Prof. Urban Pritchard, London; Prof. St. John Roosa, New York; Prof. Grazzi, Florence.

THE weather during the past week has been much disturbed by several depressions, which have caused heavy rainfalls over the whole of the kingdom, with hail and thunderstorms in many places. On the morning of September 30 the amount of rain measured on the south coast was an inch and a half, or about half the average for the month; and on the west coast, especially at Liverpool, much damage has been done by floods, occasioned by the excessive amount of rain. Temperature has been low for the season, the daily maxima rarely exceeding 60° in any part of the country, while in the north and west the readings have been much lower; frost has been recorded in the shade in the east of London, and the nights have been very cold generally. For several days a cyclonic area was situated over the United Kingdom, and strong winds were experienced on some coasts; a temporary improvement, however, occurred on Tuesday, although conditions remained very unstable. The *Weekly Weather Report* of the 1st inst. shows that the rainfall was in excess everywhere. In the south-west of England it amounted to 1·2 inch; but there was still a deficiency of 7½ inches since the beginning of the year. The temperature was below its mean value in all districts except the south of England and the Channel Islands, the deficiency being greatest in Scotland and Ireland.

SOME results of seven years' meteorological observations on the Pic du Midi, at a height of about 9500 feet, have been recently published by M. Klengel. The annual mean temperature is −2.°2 C. The annual variation, 14.°3, is only one degree less than at Tarbes on the plain, and is about that of the Sonnblick (which is some 800 feet higher than the Pic). April is abnormally cold (− 6·°2); and this is attributed to the fact that the Pic stands in Van Bebber's fifth depression-path, which is most frequented in that month. While Pipis Peak represents the extreme continental type of high mountain climates, and Etna the oceanic type, in nearly the same latitude, the Sonnblick and the Pic du Midi represent transition types. The maximum zone of precipitation on the Pic lies at about 7700 to 8000 feet; above this there is marked diminution. The results in general show that even at a height of nearly two miles the distribution of land and water on the earth's surface has a considerable influence on climate.

A SHOCK of earthquake, lasting from three to five seconds, was felt at Huelva, between twelve and one o'clock on the morning of September 29. According to a Reuter telegram, three shocks were noticed, the first being weaker than the succeeding disturbances. The direction of the seismic wave was taken from north to south, and the subterranean rumblings were heard very distinctly over a large area. The inhabitants were greatly terrified, but nobody was injured. Many windows were smashed, but beyond this the damage was insignificant.

A CURIOUS instance of globular lightning is referred to in the *Meteorologische Zeitschrift* for September 1892. On August 7, during a thunderstorm at Altenmarkt, near Fürstenfeld, while the priest was administering the sacrament, the church was struck by lightning, followed by a loud explosion. A panic immediately ensued, and the congregation rushed out, notwithstanding the assurances of the priest that there was no danger. There was nothing to show how the lightning entered the church, but it is supposed it was by the conductor leading from the steeple. It is said to have been a large globe, tapering towards the upper part, and after the explosion it left a strong sulphurous smell. The explosion was very loud and shook the building.

THE last number of the *Berichte der Deutschen Botanischen Gesellschaft* contains an interim report on the progress of the negotiations concerning the nomenclature of genera, started by a committee of botanists at Berlin to supplement the decisions of the International Botanical Congress held at Paris in 1867. The proposals submitted last April to the consideration of 329 German and Austrian and 377 foreign botanists were the following:—(1) The year 1752 to be taken as the initial date for priority in names of genera, and 1753 for the names of species. (2) Nomina nuda and semi-nuda to be rejected. Drawings and dried specimens without diagnoses to establish no claim to priority of a genus. (3) Similarly sounding generic names to be retained, even if differing only in the ending or by a single letter. (4) The names of the subsequent great or well-known genera to be preserved, even if they ought to be rejected by the strict rules of priority, especially in cases where no change in the names used up to the present can be proved. 360 replies had been received up to the time of the report, amongst them being 157 from Germany, 63 from Austria, and 19 from Great Britain and Ireland. The great majority expressed approval, at least, of the first three proposals. The botanical authorities of the British Museum favour the suggestions, those at Kew are against them.

M. G. TROUVÉ has built a luminous fountain for Mme. Patti, at her residence at Craig-y-Nos, an account of which appears in No. 11 of the *Comptes rendus*. "The weight of this fountain is about 10,000 kgr., and the basin measures 6 m. in diameter. The illuminating power is represented by four incandescent lamps of 110 volts, each consuming 6 amperes. Thus the total electric energy amounts to 2640 watts; this gives, at three watts per candle, a light intensity of over 800 candles. The lamps are centred at the focus of four parabolic reflectors grouped under the glass chambers whence the water springs. As in the chamber fountains, the metallic ajutages, which would have cast shadows, are eliminated. The water which falls from the upper to the lower basin is utilised to drive a small bucket-wheel, which governs the rotation of two superposed discs, concentric or otherwise, made of coloured glasses, which turn in the same or in the opposite sense, with equal or unequal velocities as required, between the reflectors and the glass. This combination of two discs with opposite rotations renders possible a variation in the play of colours of the liquid sheaves, which succeed each other with the unexpectedness of the kaleidoscope. The motive power can be chosen at pleasure. It may be hydraulic, electric, or by clockwork, of forms and dimensions in keeping with the character of the decoration. These fountains need neither expenses of installation nor costs of maintenance, and their price depends solely upon their artistic perfection and their importance. Hitherto the construction of luminous fountains has only been hindered by the impossibility of sufficiently illuminating the jets. To-day the problem is reversed. Since the light can be projected without sensible loss to great heights, the only difficulty will be to give a sufficiently high pressure to the water."

THE Manchester Field Naturalists' and Archæologists' Society closed the out-door session by a visit to Buxton on Saturday, September 24. The field meetings were well attended during the session, and the introduction of an itinerary for each excursion, detailing the natural history features of the district, was of service. The president, Mr. Charles Bailey, F.L.S., usually gave the address upon the botanical specimens observed. At Buxton, the chairman of the directors of the Winter Gardens conducted the party through the grounds, and undertook to convey to his colleagues the desire of the Society that the county ferns and native phanerogams, so far as they will live at the altitude of the gardens, which are a thousand feet above the sea, should be introduced.

AT a meeting of the Norfolk and Norwich Naturalists' Society, held in the Norwich Museum on September 27, Mr. Southwell exhibited, by permission of Mr. T. Ground, of Moseley, Birmingham, a Siberian pectoral sandpiper (*Tringa acumenata*), killed at Yarmouth by that gentleman on August 29, which he believed to be the first European example of this bird hitherto recorded.

THE administrative report of the Marine Survey of India for the official year 1891-92 has been published. Dr. A. Alcock, Surgeon-Naturalist to the Survey, shows that in his department the year has been by no means unproductive. He expresses his belief, however, that the results would be tenfold greater, both from the scientific and from the economic points of view, if, in the survey of inhabited coasts, the naturalist could follow the ship from camp to camp ashore, visiting it at short, convenient intervals for medical purposes, but otherwise devoting all his time to systematic exploration of the grounds worked by the fishermen—grounds of marvellous richness still quite unexplored and unappreciated.

AMONG the animals Dr. Alcock has specially observed is the red ocypode crab, which swarms on all the sandy shores of India. The bigger of its two chelæ, or nippers, bears across the "palm" a long finely-toothed ridge, and on one of the basal joints of the "arm," against which the "palm" can be tightly closed, there is a second similar ridge. When the "palm" is so folded against the base of the "arm," the first ridge can be worked across the second, like a bow across a fiddle, only in this case the bow is several times larger than the fiddle. The remarkable resemblance of the whole arrangement to the stridulating apparatus of many insects led Prof. Wood Mason some time ago to infer a similarity of function; and he asked Dr. Alcock to observe the crabs, and to listen for the sounds which he supposed them to be capable of making. Dr. Alcock is now able to give facts which establish the truth of Prof. Wood Mason's idea. The sounds can be heard, and their effects seen, if one crab, which may be called the intruder, is forced into the burrow of another, which may be called the rightful owner. The intruder shows the strongest reluctance to enter, and will take all the risks of open flight rather than do so, and when forced in he keeps as near the mouth of the burrow as possible. When the rightful owner discovers the intruder he utters a few broken tones of remonstrance, on hearing which the intruder, if permitted, will at once leave the burrow. If the intruder be prevented from making his escape, the low and broken tones of the rightful owner gradually rise in loudness and shrillness and frequency until they become a continuous low-pitched whirr, or high-pitched growl, the burrow acting as a resonator. Dr. Alcock concludes that the use of the stridulating organ appears to be that a crab, when it has entered its burrow, may be able, by the utterance of warning notes, to prevent other crabs from crowding in on top of it.

DR. FRITZ NOETLING has been investigating the amber and jade mines of Upper Burma, and sets forth the results of his inquiry in the new number of the Records of the Geological Survey of India. The strata in which the amber is found belong to the tertiary formation, probably to the lower miocene. Dr. Noetling does not think that Burmese amber would be received with much favour in Western markets—first, because it does not include the milky-white, clouded variety which has for a long time been so much appreciated in Europe; second, because of its fluorescence. This is the bluish tinge which appears when the amber is looked at under a certain angle—a tinge which is sometimes so strong that fine yellow pieces seem to be of an ugly greenish colour.

Dr. Noetling has formed a higher idea of the value of the jade mines of Burma. There are two different groups of jade mines—pit and quarry mines. The former are situated along the bank of the Uru river, beginning at about Sankha village, and extending for a distance of about forty miles farther down. The quarry mines near Tammaw village are situated eight miles west of the Sankha village, on the top of a plateau rising to about 1,600 feet above the level of the Uru river. The Tammaw mines afford the best opportunity for the study of the geological conditions under which the jade is found. It there forms a vein of considerable thickness in an igneous rock of blackish-green colour. The jade is a purely white crypto-crystalline mineral, much resembling the finest marble, containing here and there green specks of various sizes, which form the jade proper. The jade vein is separated from the black rock by a band of a soft and highly decomposed argillaceous mineral. The strike of the vein is approximately north to south, and the dip at about an angle of 20°, varying considerably towards east. There are at least 500 men engaged every season in working the quarry mines at Tammaw. The mining operations are carried on in the rudest fashion. No blasting powder being available, the rock is heated by large fires, and, having cooled down, is broken in pieces by means of enormous iron hammers. The operations in the pit mines are less difficult. The miner simply digs a pit and selects boulders of jade from the stuff dug out. Good pieces of jade are sometimes found in the laterite, which forms beds of varying thickness along the Uru. These pieces have superficially undergone a certain discolouring in such a way that the original green or white is changed under the influence of the hydrated oxide of iron into a dark red colour. Specimens of this kind are generally known as "red jade." Dr. Noetling says that the jade mines form a most valuable property. He has no doubt that besides the Tammaw jade vein others will be discovered. We know now that jade is intimately associated with a dark igneous rock (trap), and Burma abounds in rocks of this kind.

Mr. Otis T. Mason contributes to the latest report of the U. S. National Museum (for 1890) an interesting study of the ulu, or woman's knife, of the Eskimo. The ulu is found throughout the Eskimo region, from Labrador to Kadiak, and consists of a blade and a handle or grip with or without some form of lashing. The blade is either a thin piece of slate ground to an edge, a bit of cherty or flinty rock chipped to an edge, a scrap of steel or iron from wrecks of whaling vessels, or good blades made and sold to the Eskimo by traders who visit their country. The handle varies greatly in material, form, and finish. In form alone the specimens from each typical area are unique. Some of the ulus in the U. S. National Museum are as coarse as savagery could make them; others are very beautiful. The same locality furnishes both and intervening kinds, but some areas supply only coarse work. The problem has to some extent been complicated by white influence. The ulu has survived in civilized countries under two well-known forms—the saddler's knife and the kitchen knife. The saddler thus perpetuates, for cutting leather, an implement designed to be used with skins from which the hair has not been removed. The kitchen chopper is the woman's knife deprived of nearly all its ancient and primitive offices, consigned to a single one, which it scarcely had at the beginning. The saddler's knife may be seen in the hands of leather-cutters represented on Egyptian monuments. An excellent series of illustrations, grouped in accordance with the regions from which the specimens come, adds greatly to the interest and value of Mr. Mason's paper.

It is a common experience in daily life that milk has in itself little or no tendency to putrefaction, and that it may even to some extent preserve certain substances that are readily decomposed, such as meat. This property has lately been investigated by Herr Winternitz, in Strasburg. Of the three chief constituents of milk, viz., casein, fat, and milk sugar, the first proved as liable to putrefaction as the meat or pancreas extract experimented with; the fat, too, had no preservative influence. Milk-sugar, on the other hand, in accordance with what is known regarding the power of carbohydrates to retard putrefaction, acted as strongly as cane-sugar. Nothing definite was ascertained as to the nature of this action. It was proved, however, to take place in the alimentary canal as well as outside of the system.

Rats at Milnthorpe, Westmoreland, seem to have found a fresh outlet for their predatory impulses. Mr. G. Reade, in a letter quoted in the new number of the *Zoologist*, says that the ripe gooseberries in his garden there were disappearing very rapidly this year, and he supposed that the mischief was being done by blackbirds. However, his attention was called to a large rat taking the berries off with his mouth and dropping them to other rats below. Presently another climbed the tree and helped to gather the berries. In a little time both came down, each with a berry in its mouth, having a curious appearance. Mr. Reade saw the performance several times repeated. Then he placed a wire cage under the tree, and in three days caught nine of the intruders.

The electric light seems to have an extraordinary attraction for lepidoptera. On August 19, as he records in the new number of the *Entomologist*, Mr. D. S. Stewart had an opportunity of noting this fact. At the Eddystone lighthouse exhibited in the Botanic Gardens at Old Trafford (the same lighthouse as was shown at the Naval Exhibition), he saw great numbers of moths. Before ascending, he says, one could see them from below, flashing in and out of the rays in hundreds; and when the top was reached, the place was found to be full of them—"some, apparently dazzled by the light, frantically flying in all directions, buzzing and banging in your face, up your sleeves, down your neck, everywhere. In every sheltered niche and cranny four or five were to be seen together, and especially was this so on the staircase, which was strewn with their partially cremated remains, the result of their all too successful attempts at self-immolation."

A valuable paper on the breeding-habits, eggs, and young of certain snakes, by O. P. Hay, is printed in the latest volume (xv.) of the Proceedings of the U.S. National Museum, and has also been issued separately. Mr. Hay notes that, although serpents have made a deep impression on the human mind, very little accurate information has been accumulated concerning some of their habits. His paper embodies the results of a good deal of careful personal observation.

The Nova Scotian Institute of Natural Science has changed its name to the Nova Scotian Institute of Science, and has secured an Act of Incorporation. It has now begun the second series of its "Proceedings and Transactions," the first part of vol. i. having just been issued. Among the papers in this part are "Notes on the surface geology of South-Western Nova Scotia," by Prof. L. W. Bailey; "Steam boiler tests as a means of determining the calorific value of fuels," by D. W. Robb; "Analyses of Nova Scotia coals and other minerals," by E. Gilpin, jun.; "The Magdalene Islands," by the Rev. Dr. G. Paterson; "Notes for a Flora of Nova Scotia," Part 1 by Prof. G. Lawson.

Messrs. Williams and Norgate are about to publish a work entitled the "Cry of the Children," by "Free Lance." It deals with education in a wide sense, but more especially it advocates the necessity of a scientific training.

PART I. of a new work on practical physics, by Prof. W. F. Barrett, of the Royal College of Science for Ireland, will shortly be published by Messrs. Percival and Co. It will treat of physical processes and measurements, and the properties of matter.

THE University Correspondence College has issued its calendar for 1892-93. The Principal, in his report, shows that the college has been in many ways remarkably successful.

THE calendar of the Imperial University of Japan for 1891-92 affords ample evidence that the authorities of this important institution are doing everything in their power to secure that it shall meet the needs of the present age. We may note that in the college of science the following seven courses, each of which extends over three years, have been established: Mathematics, astronomy, physics, chemistry, zoology, botany, and geology.

IN the last sentence of the fourth paragraph of Lord Kelvin's article on "Generalization of Mercator's Projection Performed by aid of Electrical Instruments" (NATURE, September 22, p. 491), for "three" read "two." For corrections in paragraph 3, and in the last paragraph but one, see article "To Draw a Mercator Chart, &c.," in the present issue.

AN interesting new compound, the silver salt of the little known imide of sulphuric acid, SO_2NAg, has been obtained by Dr. Wilhelm Traube, in the laboratory of the University of Berlin, and an account of its properties, together with a considerable amount of fresh information concerning both the amide and imide of sulphuric acid, are contributed by him to the current number of the *Berichte*. Regnault long ago obtained a solid substance, which he regarded as a mixture of the neutral amide of sulphuric acid $SO_2(NH_2)_2$ with ammonium chloride, by leading ammonia gas into a solution of sulphuryl chloride SO_2Cl_2 in ethylene chloride.

$$SO_2Cl_2 + 4NH_3 = SO_2(NH_2)_2 + 2NH_4Cl.$$

The separation of the two substances, however, was but imperfectly effected, so that our knowledge of the amide itself is very vague. Dr. Traube now shows that the amide may be isolated without difficulty by the following process. The sulphuryl chloride is dissolved in fifteen times its volume of chloroform, which exerts no chemical action upon it, and dry ammonia gas is led through the liquid until the latter becomes saturated. The products of the reaction separate during the passage of the gas in the form of a white solid. The whole product is then agitated with water until the precipitate dissolves, the aqueous solution is separated from the chloroform and afterwards boiled in contact with oxide of lead or silver until all chlorine is removed from it. Upon filtering and evaporating the resulting liquid a syrup is eventually obtained, which only crystallizes with difficulty and would appear to consist of neutral sulphamide $So_2(NH_2)_2$. It is an extremely deliquescent substance whose solution in water and dilute acids is not precipitated by salts of barium or by platinic chloride. Only after prolonged boiling with hydrochloric acid does decomposition occur with the gradual deposition of barium sulphate. The effect of boiling in the presence of acids would appear to be its conversion into ammonium sulphate. Sulphamide possesses the power of combining with the oxides of mercury, lead, and silver, to form white solid substances. Thus if mercuric nitrate, lead acetate, or ammoniacal silver nitrate are added to the aqueous solution of the amide these white solid compounds are precipitated. The mercury compound is insoluble in dilute nitric acid, while the lead and silver compounds are readily soluble, forming solutions which are perfectly indifferent to barium salts. It was from the compound containing silver that the interesting silver imide was obtained. Upon heating the silver compound to the temperature of 170°–180° until ammonia ceases to be evolved, and extracting the residue with hot water feebly acidified with nitric acid, the new compound SO_2NAg separates upon cooling in long acicular crystals. Analyses have proved its composition to be that stated, and from its reactions it must be regarded as being the silver salt of sulphimide SO_2NH. The crystals are only soluble with difficulty in cold water, but more freely in hot water and readily in dilute nitric acid. The solution is not precipitated by barium nitrate. Even after removal of the silver by means of hydrochloric acid barium salts yield no precipitate; indeed, it requires long boiling with concentrated acid to effect any precipitation. It would appear that the solution left after removal of the silver contains sulphimide itself, and Dr. Traube is continuing his experiments with a view to the isolation of the latter compound.

THE additions to the Zoological Society's Gardens during the past week include a Grivet Monkey (*Cercopithecus griseoviridis* ♀) from South Africa, presented by Mr. W. Howard; a —— Lark (*Alauda cælivox*) from China, presented by Mr. Gervase F. Mathew, R.N., F.Z.S.; two Common Kestrels (*Tinnunculus alaudarius*), British, presented by Mr. L. Bergasse: a Herring Gull (*Larus argentatus*), British, presented by Mr. H. H. Johnson; a Tuatera Lizard (*Sphenodon punctatus*), from New Zealand, presented by Capt. G. Eriksen; four Smooth Snakes (*Coronella lævis*) British, presented by Mr. E. Penton, F.Z.S.; six American Green Frogs (*Rana halecina*), four Noisy Frogs (*Rana clamata*), from Canada, purchased; one Concave-casqued Hornbill (*Dichoceros bicornis*), from India, received in exchange; three Wild Swine (*Sus scrofa*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET BROOKS (AUGUST 27, 1892).—*Astronomische Nachrichten*, No. 3119, contains the elements and ephemeris of Brooks's comet calculated by F. Ristenpert, assuming an elliptical orbit and the unit of brightness on August 31·5 as the unit of Br.:—

Elements.

T = 1892 Dec. 28·2870 M.T. Berlin.

$$\omega = 252^\circ\ 4'\ 23''\!\cdot\!0$$
$$\Omega = 264\ 34\ 45\cdot3$$
$$i = 24\ 43\ 17\cdot1$$
$$\log. q = 9\cdot994136$$

Ephemeris for 12h. Berlin M.T.

1892.	R.A. app. h. m. s.	Decl. app. ° ′	Log. r.	Log. Δ.	Br.
Oct 6	7 45 22	+24 47·5			
7	48 30	24 26·9	0·2204	0·1763	3·71
8	51 40	24 5·6			
9	54 51	23 43·6			
10	7 58 4	23 20.9			
11	8 1 18	22 57·4	0·2077	0·1542	4·35
12	8 4 34	22 33·3			

This comet on the 11th inst. will be found situated in the constellation of Cancer. It will lie very nearly on a line joining the stars κ Gemini and δ Cancri, being about a third of the distance nearer the former than the latter.

COMET 1892 II. (MARCH 18).—The following ephemeris for Denning's comet we take from the *Astronomische Nachrichten*, No. 3118:—

12 *Berlin Mean Time.*

1892.	R.A. app. h. m. s.	Decl. app. ° ′	Log r.	Log Δ.	Br.
Oct. 6	6 23 9	+11 54·0			
8	22 0	11 6·3	0·4250	0·3604	0·64
10	20 43	10 17·9			
12	19 19	9 28·8	0·4300	0·3539	0·65
14	17 48	8 39·1			
16	16 9	7 48·9	0·4349	0·3478	0·65
18	14 23	6 58·4			
20	6 12 29	6 7·6	0·4398	0·3423	0·65

NOVA AURIGÆ.—In some further notes that we have referring to the brightness and the spectrum of the Nova, we find that most observers estimate the star's magnitude to lie between 10 and 10.5. Herr Belopolsky, who has examined the star spectroscopically, has been able to see one or two lines; a later estimation of the brightest gave a wave-length of 501, while the second line proved too variable in brightness to allow of a sufficiently correct measurement.

To *Astronomische Nachrichten*, No. 3118, Mr. H. Seelinger contributes a very important article, in which he suggests an hypothesis which may be said to approach that put forward by Mr. Lockyer some time ago. He assumes (and a very fair assumption too) that the cosmos contains innumerable more or less elongated forms of very thin and small particles, and that the Nova was produced by a body rushing into one of these, so to speak, clouds. On entering this cosmical cloud, at once there would be a condition for producing heat, and therefore light, and we have only to imagine the cloud to be of varying thicknesses to account for the peculiar fluctuations which attended the light of the Nova. That such a case should take place seems in itself more probable than that of two bodies passing very near one another, and we already know that such streams as suggested do exist. Our November shower, for instance, is such a swarm, only on a scale very much smaller than that inferred above.

GEOGRAPHICAL NOTES.

UNTIL recently the Samoan calendar corresponded with the Australian, but on July 4 last a change was made by order of King Malietoa. Tuesday, July 5, was reckoned a second time as Monday, July 4, thereby coming into harmony with the American and European reckoning. Samoa, lying to the east of 180°, had retained the old system of time, superseded by the general acceptance of that meridian as the line at which the date is rectified by vessels at sea.

CAPTAIN LUGARD reached London from Uganda on Sunday night. It is gratifying to know that his three years' residence in equatorial Africa, and the severe strain of recent events, have not told adversely on his health. He will probably communicate the important geographical results obtained by him to a special meeting of the Royal Geographical Society in November.

THE arrangements for the new session of the Royal Geographical Society present several new features. In addition to the ordinary meetings it is proposed to give a special series of Christmas lectures to young people; to be followed fortnightly by a course of ten education lectures, specially adapted for teachers, by Mr. H. J. Mackinder. The ordinary meetings as provisionally arranged begin on November 14 by a paper on his proposed North Polar expedition by Dr. Nansen. Mr. Joseph Thomson will follow with an account of his expedition to Lake Bangweolo. Captain Bower will describe his journey across Tibet, and Captain Lugard will recount his discoveries in equatorial Africa. Prof. Milne and Mr. Savage Landor have promised papers on Yesso, Major Rundell on the Siyin Chins, Mr. H. O. Forbes on the Chatham Islands, and Captain Gallwey on Benin. It is hoped that Mr. Conway will return to describe his adventures in the Karakoram mountains. Apart from the records of travel to which the attention af the Society in its ordinary meetings has usually been mainly devoted, there will be papers dealing with the more general and scientific aspects of Geography. The Prince of Monaco will probably describe his experiments on the Atlantic currents, Sir Archibald Geikie will lecture on types of scenery, Prof. Bonney on the work of glaciers, Mr. J. Y. Buchanan on the windings of rivers, and Dr. Schlichter on his new photographic method of determining longitude.

THE last number of *Petermann's Mitteilungen* contains an important paper by Dr. Alois Bludau giving the co-ordinates for Lambert's equivalent area azimuthal projection of the map of Africa. An outline of the continent on this projection, the central point of which is on the equator in 20° E. long., shows the remarkable suitability of the map for representing Africa, the distortion being inappreciable.

MAGNETIC INDUCTION.[1]

THE lecturer remarked that it was no less than forty-five years since the magnetic properties of materials had formed the subject of an evening discourse before the British Association. At the Oxford meeting in 1847 the lecturer was Michael Faraday, who had only a little while before made his great discovery of diamagnetism and been led to the splendid generalization that all substances are in one way or other, and in greater or less degree, susceptible of magnetic influence. And it was an interesting coincidence that in the same year, partly indeed at that same Oxford meeting of the Association, the foundation of the modern mathematical treatment of magnetism had been laid by that infant phenomenon, whom in the vigour of his maturity we were now learning to call Lord Kelvin. Discarding the arbitrary hypotheses of earlier theoretical writers, Lord Kelvin, then a stripling at Cambridge, had proceeded to give mathematical expression to the observations and intuitions of Faraday. In recent years the science of magnetism had advanced fast, keeping pace with the advance of its industrial applications. In common with other branches of electricity it had discovered the advantage of being useful. The debt which practice owed to science had been repaid with interest. In other departments of science it might be true that there were devotees whose chief pride in their work lay in their reflection that it could never be of any use to anybody: this temper of mind was not possible to an electrician. The language of electricians had passed with bewildering rapidity into Acts of Parliament and provisional orders of the Board of Trade, and the demands of industry had stimulated discovery and fostered exactness in measurement. It was the beneficent reaction of practice on science that had enabled the great work of the Electrical Standards Committee of the British Association to be brought to a successful issue. As a fruit of that work electricians were in high hope that this Edinburgh meeting would result in an international agreement with regard to the electrical units, so that whatever the Great Powers might find to differ about they would at least be of one mind as to the magnitude of the volt, the ampere, and the ohm. In the co-operation of Prof. von Helmholtz on the part of Germany, and of M. Mascart on the part of France, with Lords Kelvin and Rayleigh and their English colleagues, there were surely the elements of a Triple Alliance which should secure to the electrical world peace, not only with honour, but with precision.

The lecture of Faraday in 1847 had dealt with the condition induced by magnetic force in matter which was not ordinarily magnetic. Substances were broadly divisible into two classes, those which were strongly susceptible to magnetic influence and those that were only very feebly susceptible. The latter was by far the most numerous class, and it was with it that Faraday dealt in his lecture. The strongly magnetic substances were iron and its various derivatives, which passed by the general name of steel, also nickel and cobalt. A recent discovery by Prof. Dewar seemed to require that oxygen, in the liquid state, should be added to this list. The lecturer proposed to confine his attention to the phenomena of magnetization which were exhibited by the strongly magnetic metals. Let any one of these metals be submitted to the action of a magnetizing force such as would be produced if an electric current were passed through a coil of insulated wire surrounding the metal. As the current was gradually increased, the magnetization passed through three stages. It began very gradually; at first, while the current was still weak, there was but little magnetism developed. Then a stage came on in which the magnetic state was acquired with great rapidity; a small increase in the current now caused an enormous gain of magnetism. Finally, the process passed into a third stage, when the magnetism was again acquired slowly, and however much the magnetizing current was increased it was found to be impossible to force the magnetism to exceed a certain limiting value. This was the phenomenon of magnetic saturation. Recent researches had given definiteness to the rather vague idea which used to be expressed by this phrase, and it was now known not only that a limit existed, but what its values were in the several magnetic metals. The lecturer illustrated the three stages in the magnetizing process by means of the lantern, exhibiting curves which showed the connection between magnetism and magnetizing force, and pointed out that in special cases the three stages became extraordinarily distinct. Curves of the same kind were used to show what happened after a magnetizing force had been applied, if it were withdrawn or varied in any way. The magnetism in all cases tended to lag behind when the magnetizing force was varied, and hence these curves in any cyclic process became loops enclosing a certain area. It had been proved that this area served to measure the energy expended in carrying the substance through a cyclic magnetizing process, the reason why energy had to be spent being the tendency which the magnetism always had to lag behind the force that was operating to change it. To this tendency he had given the name "hysteresis," a term which was already of formidable significance in the ears of practical electricians. For the existence of hysteresis was the chief reason why the transformers which were used in alternate current systems of electrical distribution absorbed wastefully a considerable amount of power. The iron core of a transformer was being carried through a cycle of magnetization from a positive to a negative value and back again some 80 or 100 or 120 times a second, and every one of these periodic reversals of magnetism implied a waste of energy, which went on even when no useful current was being drawn off. It was a question of considerable practical interest, whether the amount of work wasted on the iron of a transformer was the same per cycle at high speeds of reversal such as were usual in practice, as it was in the slow speed laboratory experiments, by the help of which these cyclic curves had been drawn.

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[1] Abstract of an evening lecture delivered before the British Association, at Edinburgh, August 8, 1892, by J. A. Ewing, M.A., F.R.S., Professor of Mechanism and Applied Mechanics, Cambridge University.

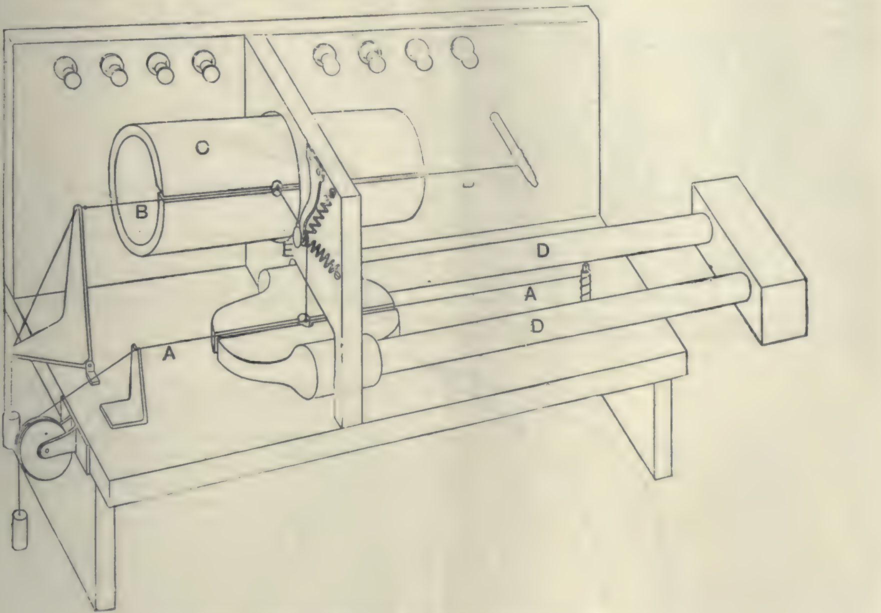

FIG. 1.—Pro . Ewing's Mognetic Curve Tracer. General view of apparatus.

The lecturer proceeded to give some account of molecular theories which had been framed to account for the characteristics of the magnetizing process. It was suggested, originally by Weber, that the molecules of iron are always little magnets, and that when the iron, as a whole, is not magnetized, it is because as many of the molecular magnets are facing one way as another. According to this view the process of magnetization consists in turning the molecular magnets round, so that they face, more or less, one way. When a very strong magnetising force is applied, the molecules are forced all to face one way; the piece is then saturated. To explain why they did not at once turn round completely when any magnetizing force was applied, Weber postulated an arbitrary directing force, which tended to hold them in their original direction. The lecturer proceeded to show by means of experiments conducted on the projecting table of the lantern, and shown on a large scale on the screen, that no arbitrary directing force was necessary. The mutual actions of the molecular magnets on one another supplied all the control that was required. It accounted completely for the three stages of the magnetizing process and for all the phenomena of hysteresis. It accounted also for the effects which were found to be produced by mechanical vibration and mechanical strain. Experiments were made exhibiting the breaking up of molecular groups, bound together by their mutual forces, under the influence of a gradually increased external directing force. In these experiments models were used, consisting of a number of small magnets, pivoted like compass needles on fixed centres, and arranged on the horizontal table of a large projecting lantern. A pair of coils placed one on either side of the group supplied deflecting force, and as the current in these was gradually increased the three stages of the magnetizing process and the phenomena of hystersis exhibited themselves in the manner in which rearrangement of the elementary magnets composing the group took place. In some of the models the magnets turned under water, so that their vibrations were rapidly damped out. Slides were also shown which gave some of the results of observations recently made in the lecturer's laboratory by Miss Klaassen, of Newnham College, which demonstrated an extraordinarily close agreement between the phenomena noticed in the magnetization of actual iron and those presented by a model consisting of groups of little pivoted magnets. Even the less conspicuous features of the actual process were reproduced in the model with a fidelity which went far to confirm this molecular theory of magnetism. It was shown, for instance, that the model reproduces a phenomenon familiar in real iron, namely, the tendency which magnetic changes exhibit to be imperfectly cyclic, under cyclic changes of magnetic force, until these are repeated several times, and also that in the model, just as in real iron, this tendency disappears if a process of demagnetizing by reversals of gradually diminishing magnetic force has been previously gone through.

The lecturer proceeded to show in action a novel apparatus he had devised to exhibit the magnetizing process in actual iron, and to test the magnetic qualities of metals. This magnetic curve tracer (Fig. 1) consists of two wires—AA and BB—tightly stretched in two narrow gaps in the magnets DD and C respectively. The magnet C consists of a piece of slotted iron tube, which is kept constantly magnetized. Consequently, when a variable current passes along the wire BB that wire sags out or in, giving azimuthal movement to a mirror E. The variable current which passes through the wire B serves to magnetize the electromagnet DD, which consists of two bars of the iron to be tested, sunk into fixed pole pieces and united at the back end by a short yoke-piece of soft iron. When the magnetism of DD varies it causes the wire AA, which carries a *constant* current, to sag up and down, and this gives movement in altitude to the mirror E. The mirror is pivoted on a single needle point, and has freedom to respond to the motion of both the stretched wires AA and BB. Since its azimuth movement is proportional to the magnetizing current, and its altitude movement is proportional to the magnetism acquired by DD, the mirror causes a spot of light reflected from it to trace out the ordinary magnetization curve, showing the relation of magnetism to magnetizing force. By making the variable current change continuously from a positive to an equal negative value and back again, a complete cycle of magnetization was performed in the bars DD, and in this way the magnetic characteristics of the bars could be completely determined in a few seconds. The lecturer proceeded to test in succession a pair of wrought-iron bars, then a pair of hard steel bars, and finally a pair of cast-iron bars, causing the cyclic curve for each material to be automatically drawn on the screen, on a very large scale, to exhibit the features of difference. The mirror and other moving parts of the apparatus were so dead beat that it was possible to go through a cycle ten or even twenty times a second without experiencing inconvenience from the effects of inertia. In that case, however, the iron must be laminated to avoid sluggishness in the magnetizing process itself. Using an instrument with a magnet consisting of a split ring of iron wire, a process of periodic reversal was performed at a speed sufficient to make the curve traced out by the light-spot become a continuously luminous line (Fig. 2), and the process of demagnetizing by reversals was illustrated by making this curve gradually contract itself to zero by slowly reducing the strength of the current while the rapid periodic reversals were continued. The effect was also shown of superposing one periodic alternation upon another, by which loops resembling those of Fig. 3 were drawn. The lecturer pointed out that these experiments went some way towards answering the question whether the magnetizing process went on in the same way, and involved the same dissipation of energy through hysteresis, at high speeds as at low speeds. He concluded by expressing the hope that this apparatus would prove of some service to the builders of dynamos and transformers by giving them a novel means of testing the magnetic properties of their iron with great completeness and in a manner sufficiently simple for workshop use.

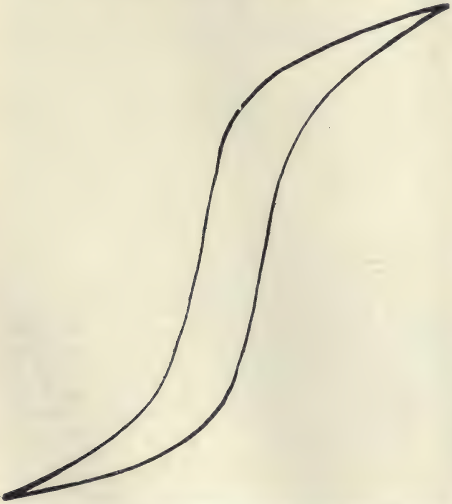

FIG. 2.—Photograph of Magnetization Curve traced by Prof. Ewing's Magnetic Tester.

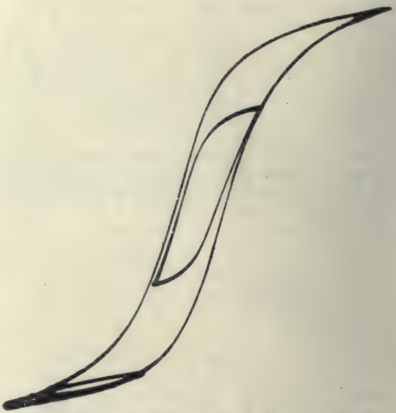

FIG. 3.—Photograph of Magnetization Curve with Loops.

BOTANICAL PAPERS AT THE BRITISH ASSOCIATION.

IN our account of the proceedings of Section D of the British Association (NATURE, August 25, p. 403), we promised to refer on a later occasion to some botanical papers which could not then be noticed. The following are abstracts of several of the more important of these papers :—

"Observations on Secondary Tissues in Monocotyledons," by Dr. Scott and Mr. Brebner. (1) The secondary tracheides in Dracæna and Yucca develop simply by the enormous growth in length of single cells, the nuclei remaining undivided, and not by cell fusion, as many authors suppose. (2) The cambium in the roots of many species of Dracæna does not appear in the pericycle, but in the cortex outside the endodermis. The secondary growth starts from the insertion of a rootlet, the cambium being pericyclic near, and cortical at a greater distance from, the rootlet. (3) Description of secondary thickening in Iridaceæ.

"On the Simplest Form of Moss," by Professor Goebel. The author stated that previous researches had led him to the conclusion that mosses and ferns did not stand in direct genetic relationship with each other, but that they are descended from simple alga-like forms ; in fact the mosses pass through a developmental stage so alga-like in appearance that it was formerly described as an algal genus *Protonema*. If the sexual organs of the moss arose not on the stem but on the protonema, we should have the sexual generation agreeing perfectly with the filamentous algæ. The leaves of the moss would then arise originally as protective organs for the antheridia and archegonia. This, up to the present, hypothetical form, actually occurs in Buxbaumia. In this moss the antheridia occur at the end of a protonema-branch, surrounded by a mussel-shaped envelope. The female plant is more highly organised, but is still much simpler than in other mosses. These and other observations lead Prof. Goebel to the conclusion that Buxbaumia is a very ancient form which stands in the closest relation to the lower algæ.

"On the cause of Physiological Action at a Distance," by Prof. L. Errera (Brussels). The author referred to Elfving's observation, that sporangium-bearing filaments of *Phycomyces nitens* are attracted by iron, zinc, aluminium, and various organic substances, such attractions not being due to gravitation, light, moisture or contact, but to physiological action at a distance, as Elfving terms it.

The author has made numerous experiments which tend to show that the attraction is really hydrotropic, the filaments being attracted by hygroscopic and repelled by non-hygroscopic substances, for example:—

Any modification of iron which lessens its capacity of rusting at the same time diminishes its attraction on Phycomyces: thus, polished steel scarcely attracts, and nickled steel does not do so at all.

China clay, which is very hygroscopic, attracts energetically, while china exhibits no attraction. These experiments succeed also in a saturated atmosphere, which shows that hydrotropism is not due, as generally supposed, to differences in the hygrometric state of the air.

"Notes on the Morphology of the spore-bearing members in the Vascular Cryptogams," by Prof. F. O. Bower. The author explained by the help of a large series of diagrams his views already laid before the Royal Society, as to the homology of the fertile frond of Ophioglossum with the sporangium of Lycopodium. In support of the probability that the former may have been derived from some such type as the latter, by a process of partial sterilization of the sporogenous tissues, he adduced facts relating to Isoëtes and Lepidodendron, both of which show a sterilization of parts of the potential sporogenous tissue in the form of trabeculæ in the sporangium.

Mr. C. T. Druery sent in a communication, which was read and remarked upon by Prof. Bower. It related to a new example of apospory found in a young fern seedling, of which the second frond bore upon its margin a number of prothalloid growths. The occurrence of aposporous development at so early a stage in the development of the sporophyte had not hitherto been recorded.

"On the arrangement of buds in Lemna Minor," by Miss Nina F. Layard. The object of a series of observations made on budding duckweeds, was to ascertain whether any fixed rule is followed, both in the arrangement and order of production of the buds.

Prof. F. Schmitz read a paper on tubercles on the thallus of *Cystoclonium purpurascens* and other red seaweeds. The tubercles are constantly inhabited by bacteria, and appear to arise in consequence of infection by these organisms.

"Calamostachys Binneyana, Schimp.," by T. Hick. The object of the paper is to revise and extend our knowledge of the structure of this fossil fruit in the light of a number of preparations which have not been previously described. The central part of the axis, formerly described by Carruthers and Williamson as vascular, the author finds to be cellular, thus removing the chief ground for Williamson's reference of the spike to the Lycopodiaceæ. Round the cellular pith there are (usually) three primary vascular bundles, which are reduced to the condition of those met with in *Equisetum*, and the young shoots of *Calamites*, *i.e.* to as many carinal canals with annular and spiral vessels adhering to the margin.

As to the affinities, the conclusion arrived at is that the fruit is that of some form of *Calamites*—as Carruthers maintained long ago—and perhaps that of the type known as *Arthropitys*.

"Myeloxylon from the Millstone Grit and Coal-Measures," by Mr. A. C. Seward. Specimens of Myeloxylon (Brong.), [Stenzelia (Göpp.), Myelopteris (Ren.)] were described from a limestone of Millstone Grit age in North Lancashire, their minute structure being fairly well preserved, and showing collateral bundles, gum canals (?), and the hypodermal tissues characteristic of the genus. A much more perfect example from the Binney collection was referred to, of coal-measure age, in which not only the xylem but also the phloem elements had been mineralised in an unusual state of perfection.

It was pointed out that in the Binney specimen the position of the Protoxylem on the Phloem side of the bundles was clearly shown both in transverse and longitudinal sections. The affinities of Myeloxylon with Cycads and Ferns were briefly discussed, and the conclusion arrived at that this extinct genus, although differing in certain particulars both from Cycads and Ferns, should be placed much nearer the former than the latter.

SCIENTIFIC SERIALS.

THE *American Meteorological Journal* for September contains the conclusion of "Objections to Faye's Theory of Cyclones," by W. C. Moore. Only a few of the more essential characteristics of cyclonic storms have been considered, but from these the author concludes that it is evident that the generally accepted theory of convectional motion gives a more satisfactory explanation of the various phenomena than the theory advanced by M. Faye.—"Changes of Plane of the Mississippi River," by Prof. T. Russell. The author analyses a report by Colonel C. R. Suter, of the Mississippi River Commission relating to the improvement of the river and methods of preventing overflow.—"Thunderstorms in New England during the Year 1887," by R. de C. Ward. The difficulty of predicting thunderstorms is shown by the fact that in New England in 1887 the majority of storms occurred in the south-eastern quadrant of cyclones, while in the previous year the majority occurred in the southern or south-western quadrant. Only 40 per cent. of the summer thunderstorms of 1887 occurred in the southern part of cyclonic storms, while in the previous year the number was 70 per cent.—"Weather Forecasting at the Signal Office, June 30, 1891," by Prof. H. A. Hazen. At this date the weather service was transferred to the Agricultural Department, and the author has given the results of his experience by laying down certain fundamental rules which would be of service to a beginner in the work, as it has sometimes been suggested that it would be almost impossible for a forecaster to impart his knowledge to another.—"The Effect of Topography upon Thunderstorms," by R. S. Tarr. The author's observations have led him to believe that topography has a decided effect upon the path of thunderstorms when they are beginning. When, however, the storm has assumed more than local proportions, topography has in all probability very little effect upon its motion.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, Sept. 26.—M. Duchartre in the chair.—On the white rainbow, by M. Mascart. A new mathematical treatment of the subject shows that the diameter of drops giving the most perfect achromatism is 29·17μ. With drops of 30μ the rainbow will appear the whiter, the more the apparent diameter of the sun hides the excess of blue intermediate between the achromatised points, as well as all the supernumerary arcs, by the superposition of several systems of fringes, so that there is only left an exterior border slightly tinged with red. The same will apply to drops slightly different in one sense or the other, but the achromatism persists longer if the diameter diminishes. The observation of clouds and fogs has shown that the diameter of the drops varies from 6 to 100μ, the last beginning to fall as rain. Thus the circumstances favouring the production of white rainbows are of very frequent occurrence.—Places of origin or emergence of the great cholera epidemics, and particularly of the pandemic of 1846–49, by M. J. D. Tholozan. From Dr. Arnott's communications to the Physico-medical Society of Bombay, from the documents of the Medical Committee of Bengal, and from the testimony of Ferrier, who was travelling in Afghanistan at the time, it is evident that the cholera epidemic which invaded Europe and America in 1847, 1848, and 1849 originated in Bokhara, whence it spread to Afghanistan and India, as well as westward. Bokhara, Samarkand, Balkh, and Kunduz were attacked at the end of the summer of 1844, Herat and Kabul in October, Jellalabad at the beginning, and Peshawur at the end of November. In the following summer the epidemic proceeded steadily eastwards into the "endemic area," reaching Jhelum and Lahore in May, 1845, Meerut in August, and Delhi and Agra in October, at the same time passing down the Indus to Kurrachee, and westwards to Meshhed, whence it proceeded in 1846 to Asterabad, Teheran, Recht, and Baku. A similar example of an eastward progress of cholera occurred in 1865, when the great epidemic of Mecca, after having invaded Mesopotamia and Transcaucasia, spread to Teheran, and took the easterly route by Khorassan. The writer expresses his firm conviction that the points of emergence of the choleraic epidemics must be considered as their points of origin. The idea that the different pandemic manifestations of cholera which have depopulated Europe must have invariably come direct from India is no longer tenable. For Europe alone, two striking examples, in 1852 and 1869 respectively, have formally demolished the theories which regarded only things coming from the East as bearing any danger of contamination. The epidemic of 1852 came from within Poland and Germany. That of 1869-73 repeated the same things in Ukraine. Nowadays, when these facts have taken their place in science, some minds seek to diminish their importance by pointing out that these epidemics revived some previous epidemics which had their origin in India. But that which makes the spreading epidemic or the pandemic is the revival of the choleraic principle or germ with all its original attributes. Even in India similar revivals perpetuate the annual endemic, and the epidemics which appear every three, four, or five years. This is the main fact which governs the entire history of cholera, and upon which micro-biological research must proceed. What difference of morphology, of virulence, or of reproductive faculty is there between the germs of the epidemics which die out at their origin, and those of the epidemics which revive several times, and can invade the whole world without proceeding from India?—Application of a conventional system of rectangular co-ordinates to the triangulation of the coasts of Corsica, by M. Hatt. The trigonometrical network drawn for the hydrographic mapping of the coasts of Corsica describes a closed curve. The employment of the conventional system, which transforms into rectangular plane co-ordinates the polar co-ordinates reckoned on the sphere round an origin, offers numerous advantages. The suppression of the sphericity permits the application of processes of calculation which have been dealt with in a preceding communication on rectangular co-ordinates. On this account it was interesting to test on a larger scale the methods which had only been utilised for the determination of secondary points. The experiment has given satisfactory results, and exhibits the practical advantages of the new system of co-ordinates and the methods of calculation. K being the length of the geodetic line joining a point to the origin, and Z the angle made by this line with a fixed direction, the conventional co-ordinates are $x = \mathrm{K} \sin \mathrm{Z}$ and $y = \mathrm{K} \cos \mathrm{Z}$. These assumptions permit the rapid and easy calculation of tables of corrections.—On a new hydro-carbon, suberene, by M. W. Markovnikoff.—Action of piperidine and pyridine on the haloid salts of cadmium, by M. Léopold Hugo.

SYDNEY.

Royal Society of New South Wales, June 1.—General Meeting.—Prof. Warren, President, in the chair.—The following papers were read:—Oceanic philology, by Sidney H. Ray; a determination of the magnetic elements at the Physical Laboratory, University of Sydney, by S. Coleridge Farr; on certain geometrical operations, by G. Fleuri; analyses of the well, spring, mineral, and Artesian waters of New South Wales, and their probable value for irrigation and other purposes, by John C. H. Mingaye; remarks on the large sunspots visible at the present time, by H. C. Russell, F.R.S.

July 5.—Chemical and Geological Section.—Prof. Liversidge, F.R.S., in the chair.—The following papers were read:—Microscopic structure of some intrusive rocks in the neighbourhood of Sydney, by Rev. J. Milne Curran; notes on the occurrence of platinum and its associated metals in the Richmond River sands, also in lode material in the Broken Hill district, by John C. H. Mingaye.

July 6.—General meeting. Prof. Warren, President, in the chair.—Paper read:—On the ventilation of sewers and drains, by J. M. Smail.

July 15.—Medical Section.—Dr. Friaschi in the chair.—Paper read:—Recent work on the pathology of cancer, by Dr. G. E. Rennie.

August 3.—General Meeting.—Prof. Warren, President, in the chair.—The following papers were read:—Flying-machine work, and the $\frac{1}{4}$ I.H.P. steam motor weighing $3\frac{1}{4}$ lb., by L. Hargrave. The paper described the experimental work carried out by the author during the past twelve months. A compressed-air-driven flying-machine (No. 16) had no less than twelve trials, on one of which it flew 343 feet, the speed being a little over ten miles per hour. On the first trial it was fitted with a bi-plane, which was found to be a very stable form. Some curious experiments with a segment of a hollow cylinder were recorded. A description was given of a steam engine and boiler for a flying-machine, the total weight of which is $3\frac{1}{4}$ lb., including fuel and water; the indicated horse-power developed was 169. Nine detail drawings were shown, including those of an air-pump and small-pressure indicator. On the venom of the Australian black snake (*Pseudechis porphyriacus*), by C. J. Martin, Demonstrator of Physiology in the University of Sydney, and J. McGarvie Smith.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Euclid, Books 1 and 2: D. Brent (Percival).—Book B; or Arithmetical Chemistry, Part 2, new edition: C. J. Woodward (Simpkin).—Tenth Annual Report of the Fishery Board for Scotland: Part 3, Scientific Investigations (Edinburgh).—Survey of India Department, General Report 1890–91 (Calcutta).—Observations made at the Hong-Kong Observatory in the Year 1891: W. Doberck (Hong-Kong).—Geological Survey Department, Ottawa, Annual Report, new series, vol. 4 (Ottawa, Dawson).—Gemeinverständliche Vorträge aus dem Gebiete der Physik: Dr. L. Sohncke (Jena, Fischer).—The Student's Manual of Deductive Logic: K. R. Bose (Calcutta, Lahiri).—Lightning Conductors and Lightning Guards: Dr. O. J. Lodge (Whittaker).—Horn Measurements and Weights of the Great Game of the World: R. Ward (The Author, Piccadilly).—The Universal Atlas, Part 19 (Cassell). Imperial University of Japan, Calendars for Years 1890-91 and 1891–92 (Tokyō, Maruya).—London Inter. Sc. and Prelim. Sc. Directory, No. 3, July 1892 (London, University Correspondence College).—London Inter. Arts Directory, No. 5, July 1892 (London, University Correspondence College).—A Treatise on Analytical Statics, vol. ii.: Dr. E. J. Routh (Cambridge University Press).—Annual Report of the Department of Mines and Agriculture, N.S.W., 1891 (Sydney, Porter).—The Birds of Lancashire, 2nd edition: F. S. Mitchell (Gurney and Jackson).—Odorographia, a Natural History of Raw Materials and Drugs used in the Perfume Industry: J. Ch. Sawer (Gurney and Jackson).—A Text-book of Agricultural Entomology, 2nd edition: E. A. Ormerod (Simpkin).—Beneath Helvellyn's Shade: S. Barber (E. Stock).—Borneo; its Geology and Mineral Resources: Dr. T. Posewitz, translated by Dr. F. H. Hatch (Stanford).—How to make Common Things: J. A. Bower (S.P.C.K.),—A Short Manual of Inorganic Chemistry: Drs. A. Dupré and H. W. Hake (Griffin).—A Text-book of Coal-Mining: H. W. Hughes (Griffin).

Pamphlets.—L'Automobile e la Filosofia Naturale e Sperimentale; Note ed Osservazioni: G. Cassola (Napoli, Gargiulo).—Epidemic Pneumonia at Scotter and Neighbourhood: T. B. F. Eminson (Kimpton).—Contagious Foot-Rot in Sheep: Prof. G. T. Brown (Murray).

Serial.—Proceedings of the Liverpool Geological Society, Part 4, vol. vi. (Liverpool).—Natural Science, October (Macmillan).—Traité Encyc. de Photographie, premier suppt.: A. troisième fascicule: C. Fabre (Paris, Gauthier-Villars).—Journal of the Royal Agricultural Society of England, vol. iii. Part 3 (Murray).

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THURSDAY, OCTOBER 13, 1892.

VIVISECTION AT THE CHURCH CONGRESS.

THE attitude of the Church towards science at the present day shows a healthy spirit of tolerance. It fully recognizes that research in physical science is the very embodiment of the seeking after truth, and that the proper exercise of faith is consonant with an attitude of expectancy. This year, however, has seen an attempt, led by Bishop Barry, to disturb this harmony and to create an exception, namely, in the case of scientific research in Biology, whether of normal structure as physiology, or of abnormal, as pathology. At the Church Congress last week the following was referred for open discussion at the instigation of Bishop Barry, who, however, wished, it is stated, to have had a much more sweeping theme presented:—

> "Do the interests of mankind require experiments on living animals, and, if so, up to what point are they justified?"

There was here presented to the Congress the twofold aspect of the question—utilitarian and moral—the obvious desire of the Subjects Committee being that they should thus have laid before them on these two points the evidence of the usefulness of scientific experiments on living tissues, and the evidence that such research is consonant with morality.

To all scientific men, even if not biologists, there is no need of evidence that experiments on living tissues are necessary to the progress of physiology and pathology. As Mr. Horsley showed in his speech, this position is *a priori* established, since the processes of life are chemical and physical in nature, and can only therefore be advanced by experimental observation whether in the laboratory or by the bedside. It seems, by the way, to have escaped the notice of all the speakers that every new clinical fact is as much the outcome of "experimental" observation as any note made in a laboratory. We would lay stress on this since not only do some dignitaries in the Church but even a few medical men seem to think that clinical discoveries are the result of inspiration, and not the outcome of trying this or that modification of factors and noting the subsequent effects. However, if the Church Congress wanted facts they were supplied in overwhelming degree, and not only facts on the utilitarian side but also many—some unexpected to judge by the excitement produced—on the moral condition of anti-vivisectionists and their beliefs. Putting aside for a moment the utilitarian side of the question, it is doubtful whether the moral responsibility of anti-vivisectionists has ever been more freely exposed to view. After Dr. Wilks had revealed the inconsistency of the agitators and their free use of animals (without anæsthetics) for their own ends, Mr. Horsley probed the consciences of the bishops by pointing out that "it has always been a matter of the utmost surprise to the medical profession that educated men in positions of the gravest moral responsibility like bishops should have in this matter descended to receive the information they require from sources of notoriously tainted character, rather than by seeing for themselves in our University laboratories what scientific experiments are in reality."

It is certainly a very fair question to ask of Bishops Barry and Moorhouse—What right had they to lend their help to any cause, however righteous it may appear to them, unless they have made a *bona-fide* effort to hear both sides? Has Bishop Barry visited the Physiological Laboratory at Oxford, or Bishop Moorhouse that and the Pathological Laboratory at Owens College? And if not, why not? Most especially ought such care to have been exercised in the case of anti-vivisectionism, since the leaders of that party have attacked not merely individuals, but the whole medical profession as "murderers," "torturers," &c., and have accused them of the grossest cruelty and self-seeking. The bishops referred to have, it is to be feared, forgotten that their office is a very reverend one, not to be lightly used to help any and every alleged reform, and above all not to be used as a means of unfounded denunciation of what Mr. Horsley truly calls an honourable, earnest, and hard-working profession.

It is difficult to see on what possible ground Bishop Barry can defend his use of the expressions "arrogance," "physiological insolence," when he applies them, as he has done, to the simple statements of fact which have been formulated into the following resolutions, the first passed at the International Medical Congress of 1881, and the second at the recent meeting of the British Medical Association at Nottingham:

> (1) "That this Congress records its conviction that experiments on living animals have proved of the utmost service to medicine in the past and are indispensable to its future progress. That accordingly, while strongly deprecating the infliction of unnecessary pain, it is of opinion, alike in the interests of man and of animals, that it is not desirable to restrict competent persons in the performance of such experiments."
>
> (2) "That this general meeting of the British Medical Association records its opinion that the results of experiments on living animals have been of inestimable service to man and to the lower animals, and that the continuance and extension of such investigations is essential to the progress of knowledge, the relief of suffering, and the saving of life."

We are glad to see that these unanimous resolutions were read to the Church Congress and appreciated by the audience at their proper value and not according to the estimate of Bishop Barry. Similarly, men of science may not only ask whether Bishop Barry was a moment justified in speaking of physiological research as "cruelty" and "demoralization" while ignorant of the real facts, but they certainly have the right to demand that, should he fail to respond to the challenge offered him by Mr. Horsley, and substantiate his grounds for making these assertions, he should withdraw from the agitation (which has, we suspect, only injured his reputation), and make a free and ample apology.

In the same manner also we would call upon Canon Wilberforce to retreat from the unworthy position into which he has been thrown by the force of feeling uncontrolled by reason, and not to make the wrong he has done to science greater by continuing to persist in it regardless of the published demonstration of his error.

One curious feature of the whole popular view of the anti-vivisectionist campaign is the general belief in the good faith of Miss Cobbe. To men of science her methods have been familiar ever since the commencement of the agitation, and more especially since they were clearly displayed in the published trial of Adams *v.* Coleridge. By the general public, however, she was regarded as a fanatic, but trustworthy. After this latter-day exposure at Folkestone to which she has been subjected we hope that such credulity has at last seen its end, for by the production of Miss Cobbe's latest book, "The Nine Circles," and by comparing it with the originals of the scientific papers from which her statements were alleged by her to be taken, Mr. Horsley had no difficulty in convincing the Congress that her statements of facts can no longer be relied upon.

It is an old story that a lie dies hard, but die it does at last, and the proceedings of the Church Congress have greatly accelerated the end.

Nothing can do this better than for scientific investigators to patiently instruct the public. At the Church Congress this heavy task fell on Dr. Ruffer, who by way of answer to the vague rhetoric of the Bishops, piled fact upon actual fact until his audience showed how they welcomed the statements of truth as a counterpoise to Episcopal excommunication.

The painful position of medical men who can be found willing to sanction such an agitation was well exhibited by the action of Mr. Lawson Tait, who having publicly charged Church Congress officials with excluding him from the meeting, was positively proved to have withdrawn himself, the withdrawal being contained in his letter read to the Congress by the chairman of the Subjects Committee, the Bishop of Dover.

Lastly, on the broad question of utility, no member of the Church would, we are sure, feel justified in contravening the view that the general regard shared by all Englishmen, and expressed in the above-mentioned resolution of the International Medical Congress, for the proper, that is, humane, use of animals, is ample surety that whether for the sake of food or pursuit of knowledge, the object is obtained at a minimum cost of pain.

The most extraordinary illogicality was displayed on this very point by Bishop Moorhouse, of Manchester, for while declaiming against the killing of animals to gain knowledge, he clamoured for liberty to destroy any number to preserve the volume of his voice.

But if we were to speak of the illogicality of the anti-vivisectionists there would be no end, seeing that as they do not or will not learn the truth, they live in a circle of contradictions. Suffice it to say, that we believe the open discussion of the subject at the Church Congress will do more than anything to show the public that the feeling exhibited by the anti-vivisectionists is one of unmitigated hostility to science, and not one of genuine anxiety for the humane treatment of animals devoted to the service of man.

THE NEW VOLUME OF WEISMANN.

Essays on Heredity. By Dr. A. Weismann. Authorized Translation. Vol. II. Edited by E. B. Poulton, F.R.S., and A. E. Shipley. (Oxford: Clarendon Press, 1892.)

IN this second volume of the new edition of Dr. Weismann's essays there are brought together four essays which did not appear in the first edition; they are in a convenient form, well translated, and well printed.

Nothing is more curious than the public appreciation of Weismann's essays, for in them is no trim, nicely balanced, carefully elaborated statement of his biological theories. The successive essays appear as they were published. You have the theories in their making, stretching from essay to essay; alive, contradictory, disjointed. This historical method of publication is a thing to delight the student of biology, but, one had thought, a torture to the precisian and caviare to the general; yet the public continue to buy, discuss, and no doubt read his works.

In "Retrogressive Development in Nature," Dr. Weismann describes cases of vestigial organs or rudimentary functions. To explain the occurrence of these, the transmission and accumulation of degenerate characters produced by disuse is unnecessary. In every organ, as in every animal, variations occur; in every generation unsuitable variations are weeded out, and so the organ or the animal remains adjusted to its environment, or becomes more perfectly adapted to it. But when a change of habit or of environment occurs, as when an eyed animal takes to living in dark caves, or when an animal that has been saving its life by swiftness comes into a region devoid of enemies, the less far-seeing or the less swift are not more quickly killed than their better endowed neighbours. So far as sight or swiftness are concerned, a condition of panmixia occurs, and the organs of sight and flight slowly degenerate.

The argument in "Thoughts on the Musical Sense in Animals and Men" is subtle, ingenious, and less familiar. In insects and birds males are the musicians, and sexual selection is a sufficient explanation; but it is not so in man. However, in the mammalia the organ of hearing is remarkably developed. In the auditory organ of a rabbit there are structural arrangements for nearly two thousand note sensations, while a concert grand piano contains only eighty-seven different notes. For the needs of life, the thousand gradations of sound in the woods and the field, of the hunter and the hunted, the mammalian organ is adapted. Music itself is an invention, and from the rude melodies of primitive man to the art of Beethoven and Chopin, it has been progressively developed as the intellectual faculties have been developed.

The third essay, "Remarks on certain Problems of the Day," is specially valuable, as in answer to certain criticisms by Prof. Vines[1] many doubtful points are explained. Specially to be noted is the clear re-statement of Weismann's contention that the nuclear substance is the sole bearer of hereditary tendencies, and the new evidence for it contained in the researches of Boveri and O. Hertwig. Equally noteworthy is the admission, in reply to Prof. Vines' citation of the parthenogenetic fungi, that not only sexual forms may vary into new species.

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[1] NATURE, October 24, 1889.

It is to the last essay, that on "Amphimixis, or the essential Meaning of Conjugation and Sexual Reproduction," that most attention will be directed Here there is a full statement, with important additions and alterations of the central part of Dr. Weismann's theories. However they may bulk in public imagining, questions of acquired characters, of retrogressive metamorphosis, and so forth, are side issues of a search for the morphological expression of the processes of variation.

Originally Weismann explained the two successive divisions of the nucleus of an unfertilized egg which form the two polar bodies as, in the case of the first, an extrusion of that nuclear plasm which, having served to guide the maturation of the egg, became useless when the egg was mature; and in the case of the second, as a halving of the nuclear substance to make way for the incoming sperm-plasm.

In parthenogenetic ova, one division and only one was predicted and found. It was suggested that parallel processes occur in spermatogenesis.

Subsequent research by O. Hertwig and others has brought to light these parallel processes, and Weismann, seeking for a sign, got rather more than he anticipated. For the processes in spermatogenesis show first a doubling of the germ-plasma, and then two successive reducing divisions, and it has been shown that exactly this happens in ova also. Accordingly, Weismann rejects his original explanation of the first polar body as an extrusion of ovo-genetic nucleoplasm, and the new problem comes to be, what is the cause of that doubling of the nucleoplasm which in primitive sperm and germ cells precedes the two reducing divisions?

Weismann supposes that the ancestral plasms or units of heredity, to which he gives the name "ids," are arranged in "idants," or nuclear rods. The doubling process takes place normally by longitudinal division, and simply doubles the number of idants without altering the arrangement of "ids." By this method the number of possible combinations is increased without alteration of the ids. The process is a mechanical one to increase the chances of combinations when the idants of sperm and germ cells meet. If the idants were coloured rods, to be arranged in pairs—say black, white, red, and yellow for four sperm idants, and orange, green, blue, and crimson for those of the egg-cell—obviously only four pairs are possible. The black would have to unite with one of the four others. But if before the arrangement in pairs each rod were split in two, there could be two combinations for black, and so on for the others. No doubt in many cases the number of idants is far greater than four, and the mechanical arrangement for variations correspondingly greater. From the large number of possible combinations there come the relative few individuals of the next generation, and there is thus a basis for the lawless and apparently capricious appearance of varieties. Next in importance comes Dr. Weismann's belief, based on theoretical considerations, and supported by experiments on *Cypris*, conducted for seven years, that in parthenogenetic reproduction heritable variations may occur. But they are far less frequent than in sexual reproduction. But the whole of this essay is full of intricate and curious speculation, speculation which will have to come before every student of biology, and which, whether much or little of it becomes incorporated in the body of accepted knowledge, will at least play a large part in guiding and stimulating present research. P. C. M.

ELEMENTARY CHEMISTRY.

The Standard Course of Elementary Chemistry. By E. J. Cox, F.C.S. Pp. 344. (London: Edward Arnold.)

THIS book consists of five parts, which may be obtained separately or bound up in one volume. It is based upon the syllabus prescribed by the Education Department for teaching chemistry as a class or specific subject, and professes to lead the beginner from the "familiar" to the "less known" by means of "investigation," the teaching thus afforded being regarded as a branch of mental education as well as of useful knowledge. The five parts deal respectively with the properties of the common gases, the atmosphere, water, carbon and non-metallic elements, and with metallic bodies, combination, symbols and formulæ.

The general plan of the book and the manner in which the subject is approached, have a good deal to recommend them; the detailed treatment contains, however, much which could be improved, and unfortunately much which the learner will have to forget as he progresses in the study of his science. In the opening chapter, evidently for the sake of simplicity, the author uses the term heat in place of temperature. More confusion on the subject of heat is made later on by the use of equations, such as

$$\left.\begin{array}{c}\text{“}\textit{Chalk}\\ \text{and}\\ \textit{Heat}\end{array}\right\}\text{yield}\left\{\begin{array}{c}\textit{Lime}\\ \text{and}\\ \textit{Carbonic Acid Gas.”}\end{array}\right.$$

which appears to attribute to heat a material existence; and even more unsatisfactory are bald statements to the effect that "no heat is produced in the formation of a mixture. Heat is produced in the formation of a chemical compound."

Considerable space is occupied in the comparison of the affinities of the elements. Because certain metallic oxides, including iron-oxide, are reduced when heated in a stream of hydrogen, the affinities of the metals for oxygen are said to be weaker than that of hydrogen for oxygen. In the case of iron and steam the author has to note that the inverse change—the oxidation of the metal by steam—readily occurs, and that the former statement as to the affinities of iron and hydrogen for oxygen, is apparently contradicted. This contradiction might have indicated the futility of attempting to compare affinities in a general way and not with reference to the special conditions under which the experiments were performed. The inverse change in the case of iron is said to occur when the "temperature" is favourable, but in reality the active masses of the reacting materials determine the direction of the change.

Inaccurate statements are numerous. Hydrogen is said to form "one-third part of water by volume," "a formula" is stated to "represent a molecule," and a base is given as "a compound of a metal with hydrogen and oxygen." More objectionable still are occasional instances of bogus reasoning, the most striking example being an erroneous proof of the conservation of mass. On three different occasions the indestructibility of matter is stated to be a consequence of the law of definite proportions. Almost equally bewildering is an attempt to show that "a molecule occupies two volumes," an attempt which even when correctly carried out might well be excluded from a book which professes to discourage anything akin to cramming. No advance is made in familiarizing the learner with accurate conceptions of atom and molecule; indeed the need for the latter conception in chemical philosophy is quite overlooked.

Throughout the book the author's mode of expressing himself is frequently not the happiest. To say that "air allows all bodies that will to take fire in it," or that "chlorine does not combine with an excess of hydrogen" is harmless enough perhaps. On the other hand to talk of the "properties of a mixture" being the "sum of the properties of its constituents," or of the gas being kept dissolved in a bottle of soda water "by the pressure of the cork," or to say that "water has weight and exerts pressure" cannot but be puzzling to the intelligent reader.

To prepare a thoroughly good introduction, of the most elementary kind, to the study of chemistry, is a work of considerable difficulty, indeed it is one which few of our leading chemists seem desirous of undertaking. Enough we think has been quoted from the book under notice to show that the author has by far underrated the difficulty of this task.

J. W. R.

LIFE AND DEATH.

Essai sur la Vie et la Mort. Par Armand Sabatier. (Paris: Babé et Cie.)

PROF. SABATIER'S "Essai sur la Vie et la Mort" forms the fourth volume of the "Bibliothèque Évolutioniste," a series of books published under the direction of M. de Varigny, with the view of expounding in a strictly scientific manner the different principles and the diverse applications of the theory of Evolution. The series most appropriately begins with a translation of Wallace's "Darwinism," and it is gratifying to our national pride to find that the two other works which have as yet appeared in the series, Ball's "Treatise on Use and Disuse," and Geddes' and Thomson's "Evolution of Sex," as well as the two others announced as in the press, are all by British authors.

The present essay, which extends over 280 pp., is the outcome of a series of lectures delivered at the University of Montpellier. It is written in a clear, simple style, devoid for the most part of all technicalities which appeal only to the specialist. The problems of life and death are dealt with from an exclusively biological point of view, and questions of morality and theology are hardly touched upon. It is difficult to do justice to the views expounded in the book in the short space at our disposal, but an attempt may be made to give a short account of its contents. The first part deals with life: the properties of living matter are considered in great detail, and Prof. Sabatier endeavours to show that the attributes of life are found to some extent, at any rate, in dead matter. According to his views "la matière brute est vivante aussi," but the manifestations are slow and dull. To the Professor's mind living matter and dead matter are not absolutely distinct: between the two states of matter there is only a difference of degree and not of kind. "La vie donc est partout, dans la matière dite inanimée comme dans la matière vivante." The various features in which dead matter behaves like living, are considered at great length; but, curiously enough, no mention is made of Bütschli's remarkable experiments on artificial amœbæ, recently described in the "Quarterly Journal of Microscopical Science."

This view being accepted, death in the ordinary sense of the word, naturally cannot exist, and the phenomenon which we usually call death becomes but another form of life—"la vie intense" simply passes into the state of "la vie lente." Immortality, according to our author, consists in the indefinite continuity of life ("la vie intense") without arrest or interruption. Like Weismann, he maintains that the negation or the contrary of such immortality involves the presence of a dead body or corpse. Weismann holds that ciliated infusoria are immortal if kept under favourable conditions, these conditions, of course, including frequent opportunities of conjugating. Sabatier considers that such infusoria are only potentially immortal, and that the act of conjugation converts this potentiality into a real immortality. In his opinion the primitive protoplasm was immortal, and the habit of dying has been acquired by the higher organisms in response to two stimuli, one internal and one outside themselves. The internal cause of death is associated with a tendency innate in the living being to improve its position in the world, in response to which it has become more specialized, and developed new organs and powers. This specialization has borne with it the seeds of death. The external cause is the surrounding world, which constantly stimulates and promotes the organism to new efforts, and in the struggle for the mastery death is brought about.

Although we fail to see that Prof. Sabatier has thrown any new light upon the problems he attempts to solve, and although the explanations he advances seem to us inadequate, his book is a useful one, inasmuch as he gives us a careful summary of the numerous views advanced by various writers in the last twenty-five years, on the subject of life and death, and criticises with considerable ability the theories of Weismann, Goette, Minot, &c. In fact, his destructive powers seem greater than his constructive.

A. E. S.

OUR BOOK SHELF.

Contagious Foot Rot in Sheep. By Prof. G. T. Brown, C.B., 16 pp., 8 illustrations, (John Murray).

THIS pamphlet is a reprint from the second part of the current volume of the Royal Agricultural Society's Journal. A few additional remarks on the prevention of foot rot have been added, and if the instructions given were fully carried out, the disease would soon cease to be troublesome. The preventive suggestions are (1) separation from the rest of the flock for one month of all animals newly purchased; and (2) isolation of all animals affected.

In discussing the treatment of the disease, Prof. Brown insists upon the importance of detecting it at an early stage, and in the first part of the pamphlet he explains how to do this with certainty.

The pamphlet ought to be read by everyone interested in agriculture: and to make it better known the Society has printed as a leaflet a few notes upon the subject. In America the pamphlet would be sent broadcast amongst those interested, and it is to be hoped that Government assistance may soon enable our own Agricultural Society to disseminate knowledge in a similar way.

W. T.

How to Make Common Things. By John A. Bower. (Society for Promoting Christian Knowledge, 1892.)

IT would be a strange boy who never wanted "to make something." The present little book has been prepared for boys who feel this desire very strongly, but do not quite know how to set about the fulfilment of their wish. They will here find ample information on the best way of making a vast number of things, from a hat-rail to a galvanometer, from a pair of stilts to a needle-telegraph. The author assumes throughout that those whom he addresses are not being taught by a personal instructor in handicrafts, and that they are not the possessors of an elaborate array of tools. His directions are clear and practical, and cannot fail to be appreciated by boys who find much to interest them in the exercise of ingenuity and manual skill.

The Student's Manual of Deductive Logic, Theory and Practice. By K. R. Bose. (Calcutta: S. K. Lahari and Co., 1892.)

THIS book is intended for the use of students at the various Indian colleges, and will be regarded by most teachers of the subject as, upon the whole, a very good text-book. The author has read many of the best European writers on logic, and presents clearly a summary of their results. He begins with a definition of logic, gives some account of its "branches and parts," and then considers terms, propositions, and inferences. What he himself describes as "the distinguishing feature" of the book is a collection of problems and exercises with solutions, or hints towards solution, in close correspondence with the subject-matter of the text.

A Text-Book of Agricultural Entomology. By Eleanor A. Ormerod. Second Edition. (London: Simpkin, Marshall and Co. 1892.)

THE first edition of this book was published about eight years ago. It consisted of lectures which the author had delivered at the Institute of Agriculture of South Kensington. There was not much demand for it until last year, when attention was directed to it by the arrangements of the County Councils for the promotion of agricultural education. The work was then so widely appreciated that a new edition was soon called for, and there can be no doubt that in its new form it will be more popular than ever, for Miss Ormerod has done everything in her power to make it not only scientifically accurate but practically useful. Students will find it of great service in helping them to a knowledge of insect life and of the best remedies for "infestations."

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Functional Hermaphrodite Ascidian.

AS of late years a considerable number of structural hermaphrodites have been shown to be protogynous or protandrous, or to have some special modification for the purpose of preventing self-fertilization, it may be of interest to have on record a case of a completely functional hermaphrodite.

I had living lately in one of my dishes a large *Ascidia* (probably *A. rubicunda* of Hancock) which I observed one morning to be expelling eggs from the atrial aperture. The eggs were emitted in batches of from about twelve to twenty at a time, and immediately after each set of eggs came a little white milky jet which hung like a string in the water for a few seconds and then spread out and disappeared. On catching some of this string in a pipette and examining it with the microscope it was seen to be a mass of active spermatozoa. This alternating passage of ova and spermatozoa continued for fully an hour.

The ova at first floated at the surface of the water for a short time and then slowly sank to the bottom. On examining some of those on the bottom of the dish after a couple of hours they were found to have commenced development, being in various stages of segmentation: so there can be no doubt that self-fertilization had taken place.

Very likely this occurs in some other species also, but another common Ascidian (*Corella parallelogramma*), of which I had had several large specimens living a few weeks before, laid eggs in my dishes, and I could not detect any spermatozoa being produced by these individuals. They were functionally female although structurally hermaphrodite.

W. A. HERDMAN.

University College, Liverpool, October 3.

The Present Comets.

ON the 27th ult. about 15½h. G.M.T. comet Brooks (*c*, 1892) had a tail 10′ long, pointing at a position-angle of 280°.

At the latter part of last month Swift's comet (*a*, 1892) was still a very conspicuous object in a 4½-inch refractor. Observations on several nights showed that it not only still had a very faint tail—at position-angle 260° on the 24th at 8½h, when I observed it to be certainly 11′ long, and suspected it to 21′—but that also there was an elongation nearly in the opposite direction; while I believe the radius of the head was less towards *n* than towards *s*, but I have not been able to satisfy myself of this.

Sunderland, October 5. T. W. BACKHOUSE.

Women and Musical Instruments.

IN looking over a very large collection of musical instruments from the aborigines of America, I am surprised to find that there is not one peculiar to women, and that those of the men are never played by the women. It is true that the females beat time on various objects and may now and then use the rattle. This disappointing fact arrested my attention, and I am curious to know whether savage women, or any other women for that matter, have ever invented a musical instrument, and whether in savagery they even play upon those invented by the men. The composition and singing of songs might also be inquired into, though our American savage women do join in certain choruses.

OTIS T. MASON.

Washington, U.S.A., September 26.

Determination of *g* by Means of a Tuning Fork.

MR. C. V. BOYS informs me that for the converse process of determining the pitch of a tuning-fork, the experiment I described recently is no new one, but has been used by him for the last ten years in the instruction of students in South Kensington. I observe, however, that he has not made the same use of the trace to eliminate the zero error.

A. M. WORTHINGTON.

THE TOTAL ECLIPSE OF THE SUN, 1893.

AS I have been asked by some astronomers to give a description of the general appearance and climate of this part of Chile, in which a total eclipse of the sun occurs next year, I have drawn up for publication the following account:—

The eclipse takes place on April 16, 1893, at about 8.15 A.M., Chile local time, and will be seen to the greatest advantage in this part of the Province of Atacama.

At the sea coast the central line of total eclipse passes close to Chañaral 29° S.L. This is not the better known Chañaral, north of Caldera, but a small place equidistant from Coquimbo and Carrizal Bajo. The southern limit of total eclipse is 29° 50′ S.L. just north of Coquimbo, and the northern limit 28° 10′, just south of Carrizal Bajo.

The band of total phase stretches between these two limits in a north-easterly direction, across the country, from the coast towards the rising sun. Along the central line of this band the sun will be hidden by the moon for nearly three minutes. The eclipse will be total everywhere within the limits given above, but the total phase will be shorter and shorter the nearer those limits are approached, and outside of them the eclipse will be partial.

On the accompanying map of the Carrizal and Cerro Blanco and Copiapo Railway systems I have marked the northern and southern limits, and the central line of totality.

It will be seen that the port of Carrizal Bajo, 28° 4′ S.L., is just outside the total band, but the railway connecting it with Yerba Buena intersects the central line of total eclipse 70 miles inland, and a branch to Merceditas, 60 miles inland, at an altitude sufficiently high to be above the damp and hazy atmosphere of the coast. At the points of intersection the climate is simply perfect for astronomical observations, and is also, during the month of April, delightful to live in.

The accompanying form was filled up, in compliance with a request from Amherst College Observatory, to show the cloud conditions in the inland region during the month of April this year as an indication of what might be expected during the same month next year.

Cloud Observations at "Mina Bronces," Chile, 1892.

Day.	Local time.			Remarks.
	7.45 a.m.	8.15 a.m.	8.45 a.m.	
April 10	2	2	2	Clouds were light, allowing a slight shadow to be cast. Bright sun at intervals.
„ 11	2	0	0	Clouds were on the horizon, so that the sun rose above them at 8 o'clock.
„ 12	0	0	0	Perfectly clear sky.
„ 13	0	0	0	Perfectly clear sky. Sun rose at 6.22 a.m.
„ 14	0	0	0	Sun rose at 6.22 a.m.
„ 15	0	0	0	Fresh wind. Sun rose at 6.23 a.m.
„ 16	0	0	0	Sun rose at 6.24 a.m.
„ 17	0	0	0	
„ 18	0	0	0	Slight haze at sunrise. Sun rose at 6.25 a.m.
„ 19	2	0	0	Bank of clouds near north-east horizon, which the sun rose above at 8.05.
„ 20	0	0	0	Sun rose at 6.26 a.m.
„ 21	0	0	0	„ „ 6.27 „
„ 22	0	0	0	„ „ 6.28 „ Strong wind.
„ 23	0	0	0	„ „ 6.29 „ „ „
„ 24	0	0	0	
„ 25	0	0	0	
„ 26	0	0	0	
„ 27	4	3	3	Haze thick at 8.15 a.m., but light at 8.45 a.m.
„ 28	0	0	0	Sky got cloudy at midday.
„ 29	0	0	0	
„ 30	0	0	0	

KEY.

0 = "Sun entirely clear from clouds."
1 = "Clouds generally scattered."
2 = "Clouds massed about the sun."
3 = "Sun in haze or fog."
4 = "Sun invisible in thick clouds."

I had two series of observations made, one at Mina Bronces by Mr. Martin, chemist to the works (the results of which are hereto appended), the other at Cerro Blanco by Señor Miranda, at his mine. Both reports are in every respect alike. The 10th and 27th were cloudy, all the other days absolutely clear. As the two stations are some twenty-five miles apart, these reports show that there is no local weather, and that it is only when a general atmospheric disturbance, originating in the Cordillera de los Andes, occurs that the weather is affected at these high stations.

It will be seen that there was only one day—the 27th—out of twenty-one days of observation on which the sun was not visible at eight o'clock in the morning, for on the other cloudy day—the 10th—the sun was bright at intervals.

Observatory Stations.

I have marked on the map, along the central line of totality, several stations that I think suitable for observatories; the positions are only approximately correct, for I have no means of determining them accurately, but the errors, if any, cannot be great.

Undernoted are heights above sea level of some places shown on the map:—

Yerba Buena railway terminus	3867 feet
Cerro Blanco, north hill	10,000 „
„ south, Peineta	8000 „
Carrizo, in the valley, a small farm ...	5000 „
Merceditas railway station	2900 „
Cerro del Jote	6000 „
Cerro del Cobre	8000 „
Lay observatory	4000 „

Cerro de Peineta is part of Cerro Blanco; this Cerro Blanco is not part of the Andes, but a detached hill with low ground all round, and a clear view to the north-east. It is easily ascended by pack-mules.

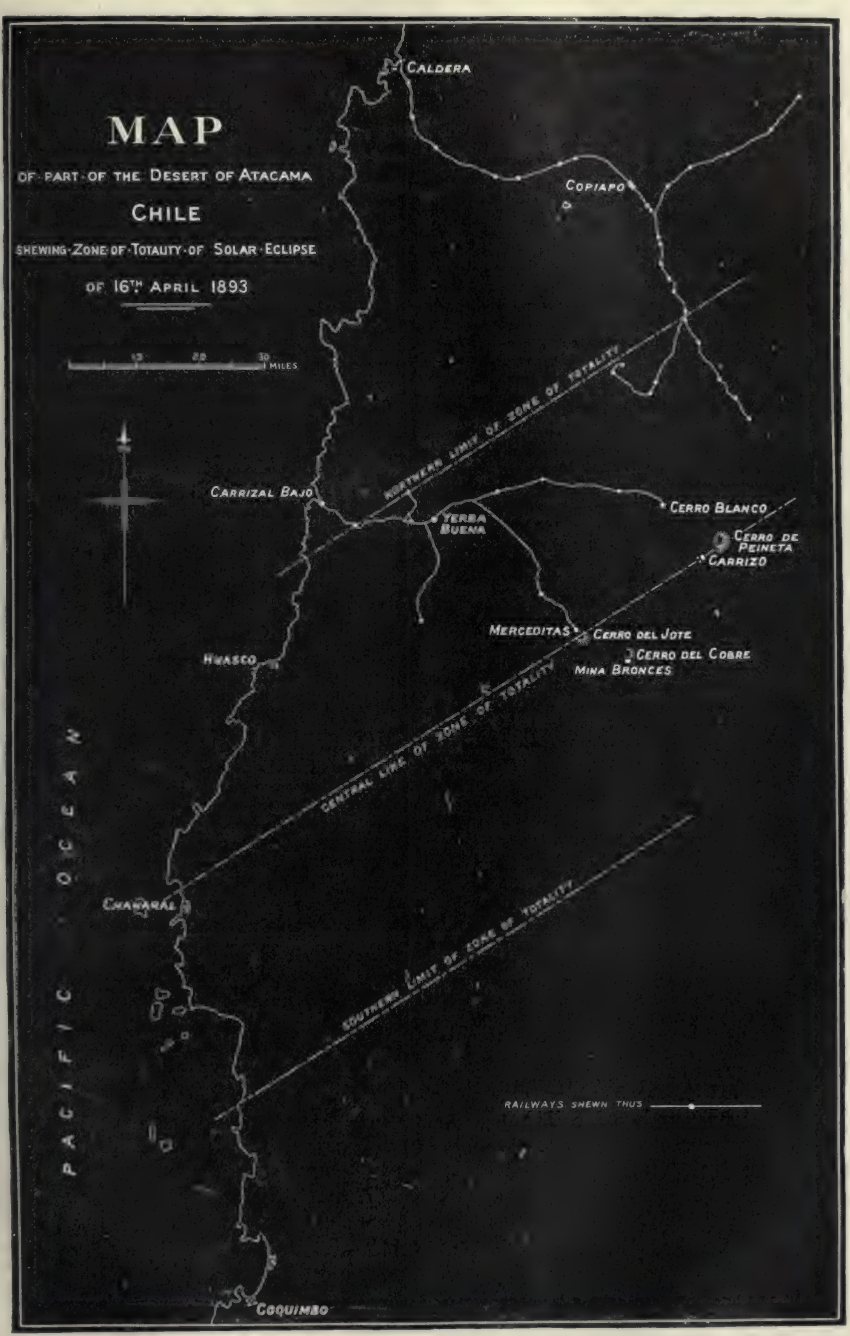
Carrizo is not a hill, but a small farm or large garden, irrigated by a mountain stream. The advantages of this station are: nearness to the railway, a good road, and plenty of small hills of easy ascent to select from.

Cerro del Cobre is a good hill, but probably too far south. However, there are hills all the way from Merceditas that might be selected (see Mr. Martin's letter).

Serra del Jote, near Merceditas, is accessible to pack-mules half-way up, higher than which it would not be necessary to go. Moreover, it is said that the rest of the ascent is difficult. The three hills, Cerro de Peineta, Cerro del Cobre, and Cerro del Jote, can all be seen from one another.

Lay Observatory. On April 15 I went to Merceditas and stayed overnight, as I wished to find near the railway station a hill on which the sun shone at an early hour on the morning of the 16th, through some opening among the surrounding hills, and which would be suitable for ordinary lay observers who had no expensive apparatus, but who wished to see the eclipse well through a smoked or coloured glass. To the south of the railway station I found a range of hills eminently suited to the purpose; at a height of 4000 feet above the sea the sun shone over a dent in the Jote at 6.40 a.m. The hill is much higher than 4000 feet, but I did not go higher. This is an excellent, well-sheltered spot, and would do well as a station for professional astronomers. I went up on horseback in forty minutes, but the ascent, from the railway station, could be easily made on foot in an hour. As I could not find any local name for this hill, I called it the Lay Observatory.

Climate.—At two o'clock in the afternoon of April 15


MAP
of part of the Desert of Atacama
Chile
shewing Zone of Totality of Solar Eclipse
of 16th April 1893
10 20 30 Miles
Caldera
Copiapo
Northern Limit of Zone of Totality
Carrizal Bajo
Yerba Buena
Cerro Blanco
Cerro de Peineta
Carrizo
Merceditas
Cerro del Jote
Cerro del Cobre
Mina Bronces
Huasco
Central Line of Zone of Totality
Chañaral
Southern Limit of Zone of Totality
Pacific Ocean
Railways shewn thus
Coquimbo

the temperature at Merceditas was 78° F.; this was the hottest time of the day, and it was a warmer day than usual, and at 8 p.m. the temperature was 62° F. Next morning, the 16th, I got up at two o'clock to see the comet then visible, and found the temperature was 58°; at 5 a.m. it was 56°.

Everywhere on the coast of Chile, north of Coquimbo, the sun, in the morning, is almost always obscured by a thick haze which makes the sky of a dull lead colour. This haze is sometimes driven away by the sun during the forenoon, but just as often it remains all day, especially during the months of March, April, and May.

This hazy morning atmosphere extends inland for a distance of about 40 miles and up to an elevation above the sea of about 2500 feet; beyond this distance and height the sky is almost always clear and the air dry. Standing, in the early morning, on a mountain of 3000 to 4000 feet, or higher, you look down on a great white sea of mist covered with whiter ridges like motionless waves, and studded here and there with islands, which are the mountain tops piercing through. This haze is usually gone by nine o'clock, except within about five miles of the sea.

Accommodation on the Hills.—Tents can be quickly and cheaply made with "esteros de totora," that is mats made of reeds. All the more temporary houses of miners and prospectors and of railway track repairers are made of these mats, which are seven feet square, and may be rolled up and carried from place to place. They form an article of commerce, and cost eighteen-pence each, or from eighty to ninety cents. of Chile paper currency. During all the month of April and part of May it is quite safe to trust to this kind of tent, but not later than the middle of May, for rain or snow sometimes falls in the end of that month.

There are no venomous reptiles in Chile, nor are there mosquitoes on these hills, and fleas cannot live at an altitude of 4000 feet—no slight advantage.

Rain.—On the Chilian side of the Andes, in the province of Atacama, rain generally falls twice in the year: the first rain is expected in June, the next in July, each rain usually lasting two days, and always accompanied with wind from the north. As soon as the wind changes to its prevailing quarter, the south, there is beautifully clear but cold weather. From two to three inches of rain fall in the year, but sometimes less than one inch. On Cerro Blanco it usually freezes every night from July till the end of August, and some snow lies on the mountain till September. On the hillsides there are plenty of bushes and small trees for firewood, and excellent water is found in all the higher valleys.

I have heard one objection to this district for observing the eclipse, which is, that as the eclipse takes place in the morning, and the sun is not high in the sky, it would be better to go farther east. This objection has no weight, on account of the extreme dryness of the atmosphere. At the mines on Cerro Blanco and the other hills everything gets dried up; Huasco raisins grow hard and rattle on one's plate like nuts; agricultural produce, such as wheat, beans, and barley, brought from Southern Chile as food for man and beast at the mines, loses two per cent. of its weight every month for several months, office ink bottles have to be kept tightly corked or the ink very soon dries up, chairs and tables fall to pieces, veneer peels off, and a piano soon loses its tone. The sky is dark blue, and the sun rises white and dazzling without a trace of any other colour. The hills, the rocks, and the bushes cast dark shadows, and even every pebble the size of a hazel nut casts its shadow, so that in the early morning the gravelly ground seems half wetted with a shower; one side of every pebble is in bright light, the opposite in deep shadow.

Although the eclipse would be the object of greatest interest to visitors, a few weeks might be profitably spent among the copper mines, and if any one wished to become a mine owner, plenty of mines are to be had for the asking. Alll the mines belong to the State. You have only to take up a mine, pay a nominal licence to the Government annually, and the mine is yours as long as you pay the licence. There are no royalties, no surface rents, and no export duties. The next thing to do is to make the mine pay, and this is sometimes done.

There is no sport in April, but after snow falls on the Cordillera, huanacos and immense flights of turtle-doves come down to feed on the lower slopes. Life, however, is never wanting. The region from Cerro Blanco southward as far as Coquimbo is the home of the fur chinchilla. It feeds on the nut of the carbon tree, *Cordia decandra* (Hook. et Arn.), and on the pea of the algarrobillo, *Balsamocarpon brevifolium* (Clos.). This bush, which produces the tannin pod of commerce, thrives best far inland, on sunny, almost rainless slopes, but it must have one shower in June or July, otherwise it bears no fruit. If there be no rain for three or four years—as sometimes happens—the bushes do not die—they just wait. The same thing happens with all the other bushes; sometimes, for several successive years, they are without leaves, and though the soil seems as dry as dust, whenever rain comes they show themselves full of life.

British astronomers—professional and amateur—ought not to lose the opportunity of observing under such favourable circumstances this great eclipse. I doubt if better conditions were ever offered before. The distance to come is long, but the expense is not very great, and can be exactly counted beforehand. An expedition might leave Liverpool in February, by Straits of Magellan steamer, and be home again in June. Or, after the eclipse, go by steamer to San Francisco or Vancouver, and thence by rail to the World's Fair at Chicago, and instead of encountering hardship and danger in some unhealthy climate, have a pleasant trip all the way.

Though horses and mules can be got here, every one should bring a saddle and bridle.

In conclusion I would impress on the members of every expedition that may come out, the importance of selecting, as observing stations, places at a distance of at least 60 or 70 miles from the sea. On the other hand, the advantages of going farther inland are doubtful, and as the railways go no farther, travelling would be more difficult.

JOHN KING,
British Vice-Consul, Carrizal Bajo, and Engineer of the Carrizal and Cerro Blanco Railway.

Carrizal Bajo, Province of Atacama, Chile,
May 1892.

(COPY OF MR. MARTIN'S LETTER.)

Mina Bronces, Jarilla, May 2, 1892.

DEAR SIR,—I have now the pleasure of enclosing the form which you sent to be filled up. As I did not receive your letter till April 9, I could not of course fill in the first nine days, but as you will see by the observations that as the last twenty days have been almost invariably clear, I think the astronomers could safely decide to come here as far as clearness of sky is concerned.

An observatory could very easily be placed on one of the spurs of the Cerro del Cobre, to the south of the latter. It is easily accessible to mules with 250 pounds and affords an uninterrupted view of the sunrise.

Hoping that the filling up of the form will be found to fulfil all requirements. I remain, dear sir,

Yours sincerely,
(Signed) WILLIAM M. MARTIN.

John King, Esq., Carrizal Bajo.

DR. MODIGLIANI'S RECENT EXPLORATIONS IN CENTRAL SUMATRA AND ENGANO.

LITTLE more than two years ago, writing in this journal on the results of Dr. Elio Modigliani's accurate and highly interesting exploration of Nias (NATURE, vol. xli. p. 587), I made the remark that our young traveller had shown that he was made of the stuff of the very best of scientific explorers. It is therefore with no small pleasure and pardonable satisfaction that I now have the good fortune to show further proofs that I was not mistaken in thus judging him.

Those who have once tasted the sweets of true exploration in little-known lands, and who are animated by the smallest spark of *fuoco sacro*, have felt and know well that thirst for further travels which goads the late traveller to new wanderings. It was thus with my friend Modigliani, and he had hardly finished seeing his book on Nias through the press, when he began to long to be away again. He first thought of taking off the edge of his peregrinatory desire with a visit and collecting tour to the less-known parts of our new "Eritrea," but an accident, which might have had serious consequences, kept him back on the eve of departure. On regaining his health, far from being discouraged, he matured a wider and bolder plan—that of returning to the vast and lovely lands of the Malayans, and penetrating to the heart of Sumatra through the country of the Toba Battaks.

Dr. Modigliani left Florence in August 1890. Early in October he was at Siboga, then at Padang-Sidempuan, in Sumatra, where he interviewed Mr. van Hasselt, well known in connection with the big Midden Sumatra exploration; however, as the sequel proved, not much information and aid were got from Mr. van Hasselt and his Government; besides, war was going on in the Toba region, but this did not deter Modigliani from his object. He had secured the services of Abdul Kerim, the Persian collector and taxidermist, who had been with Marquis G. Doria from 1862 to 1874, first in Persia, then in Borneo and Tunis, and finally at the Museo Civico at Genoa, which, under Doria's energetic and enlightened direction, has, during the last twenty-five years, been one of the most active and fertile centres of zoological research in the world. This was fortunate, for the Javanese hunters and collectors engaged at Buitenzorg were not very efficient.

Although he included in his baggage only things that were strictly necessary, he had to engage at Siboga forty-one carriers, mostly Toba Battaks, to convey it to the lake. That route, hardly practicable twenty years ago, is now safe, and the only trouble met with was from Dutch convicts engaged in repairing the road. It was on this road, at Ayer Kotti, that the American missionaries, Messrs. Munson and Lyman, not many years ago, were killed and eaten by the Battaks of the neighbouring village, Huta Sakkak. The country rises continually from the coast until the highlands of the Toba plateau are reached; it is undulated with mountains and broad valleys, such as that of Silindung, but on the highlands the forests have disappeared, and the watered depressions with dense vegetation and the clumps of bamboos surrounding the villages are dotted about. At Tarutung, the principal village of Silindung, Modigliani obtained important information on the independent Battaks from Mr. Welsink, the Dutch Assistant-Resident, who had long resided in the Battak country, and been some time *Controleur* at Laguboti on Lake Toba, now occupied by the Dutch. The Singa Manga Rajah, head chief and religious primate of the Battaks, who had already given so much trouble to the Dutch, was again coming to the front, and this time in connection with the irrepressible Atchinese from the north—an alliance of hereditary foes, for the Battaks have always repulsed the Mohammedan Malays against the invading whites.

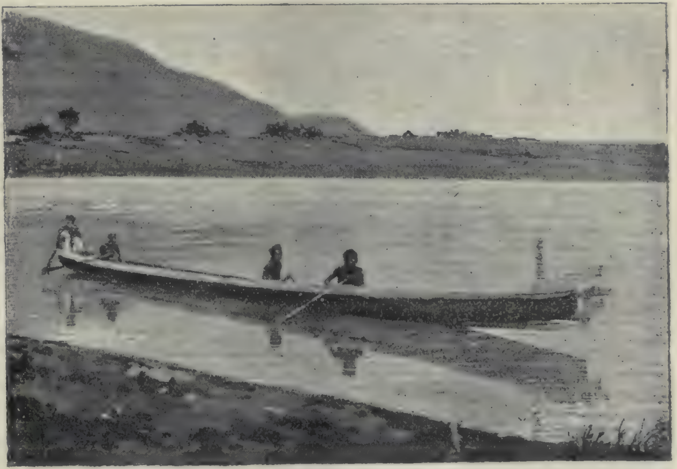


FIG. 1.—*Solu* (boat) on Lake Toba.

By the middle of October 1890, Modigliani was at Balige on the shore of Lake Toba, and on the edge of the wild and unexplored Battak country, the land of his dreams. He describes the lake as grand and imposing, but more like a northern lake, such as Loch Lomond, because of its bleak bare mountains and early mists, than what might have been expected in the heart of a tropical island. Lake Toba is about forty-four geographical miles in length; a large mountainous peninsula divides it in two—Tao Silalahe on the north, and Tao Balige on the south. At Balige Modigliani had the use of a good house, once occupied by Mr. Welsink. He paid an early visit to the *Controleur*, Mr. van Dijk, at Laguboti, who placed at his disposal the Government boat with its crew, but requested to be informed of any excursion on the lake beforehand, as some of the lacustrine villages were hostile. Modigliani started for a first exploration of Lake Toba on October 27. An old chieftain, Ompu Rajah Doli, went with him, partly as guide, partly as protector. He was on his *solu*, the long swift canoe, excavated from a single tree, with which the piratical enterprises on the lake are so deftly performed; this, not one of the largest, was 18 metres long and 1 metre in width; it was manned by eighteen paddlers and one steersman. The place of honour is at the prow, which is singularly ornamented. At Ade Ade, one of the further villages, he secured the good will of the powerful chief, Ompu Rajah Hutsa, and with him visited the site of Lumban Rajah, the former residence of the Singa Manga Rajah, destroyed by the Dutch. The chiefs and head men of several neighbouring villages had assembled, and many were the questions they put to Modigliani. Amongst others, they asked him who was his Rajah. "The Rajah Roma," said he. This caused a great discussion, after which one of the chiefs said: "How is it that we, having sent to Rajah Rom (not Roma) presents of horses and buffaloes, have never received a return or an answer?" Modigliani was at first rather embarrassed at so direct a question, but replied that the presents had not been received, having perhaps been intercepted. This appeared to convince them, and a Rajah Uti was mentioned as apparently the guilty party. I have mentioned this episode because it turned out to be a most fortunate one for our traveller, who got to be known as the envoy of Rajah Rom, and even as that mystic personage himself. It appears that by that name a venerated authority is known to the Battaks, and Modigliani thinks it may be no less a personage than the Hindu god Rama. As the sequel will show, under the patronage of Rajah Rom, Modigliani was able to penetrate into the heart of the independent Battak country, where, in all probability, no other European would have been able to go; and many were the things he had to promise in Rajah Rom's name, and many the presents and great the aid he got as his envoy. The greatest depth found by Modigliani in Lake Toba was 450 metres; the temperature of the water was 24° to 23° C. at the surface, and 23° to 22° C. near the bottom. Only four species of fish, two of molluscs and two of crustaceans, appear to live in the lake.

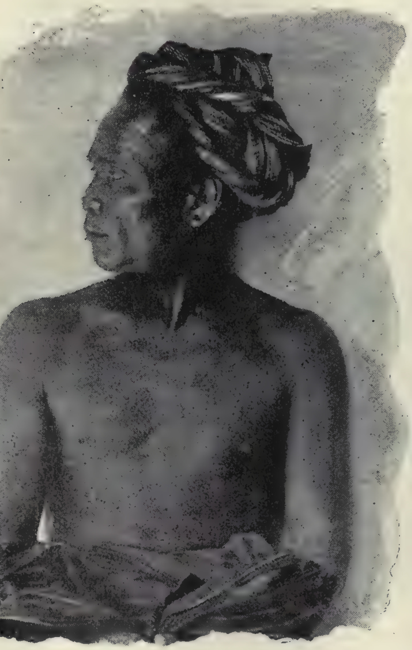


Fig. 2.—The *guru* Samalain.

As a locality better suited for zoological collections, Modigliani went in November to live in the forest of Si Rambe, where, at an elevation of about 1370 metres, he built himself a log hut. Here the maximum day temperature ranged from 28° to 30° C., the minimum night temperature from 12° to 13° C.

It was from his hermitage in Si Rambe that Modigliani, eluding the official impedimenta, started on his adventurous and bold journey across Sumatra, right through the country of the independent and hostile Battaks. Now his supposed connection with the legendary Rajah Rom did him a right good turn; for the yet more or less independent chiefs sought him out, hoping that through his influence Rajah Rom might be induced to redress their wrongs. Amongst these was a *guru*, one of their priests, wise men, and *literati*, named Samalain, a staunch friend of the Singa Manga Rajah, who not only visited Modigliani but undertook to guide and protect him in his exploration of the (by Europeans) untrodden Battak territory. In one of his letters to Marquis Doria, Modigliani gives a vivid description of the savage energy of *guru* Samalain, of his devotion to the Singa Manga Rajah, and of his love of independence. The *guru* sent seven of his devoted followers to act as carriers, and taking one of his Javanese hunters and his interpreter, Si-gu-tala, a Battak, Modigliani left his encampment in the forest of Si Rambe at midnight on December 19, 1890. The utmost caution was necessary to cross the frontier line without being discovered by the colonial authorities. After a forced march of ten hours, the *guru* having joined him on the way, Modigliani reached the village of Lumban Bulu, well within the territory of the independent Battaks. The village chiefs, with armed retainers, and those of some neighbouring villages, all fully armed and equipped, with spears, flint-lock muskets plated with silver and ornamented with ribbons, and their peculiar swords with heavy ivory handles, accompanied and surrounded him. His reception was far from friendly. They would not believe that he was not a Dutch emissary, and spoke of sending him back; even the energetic protestations of the *guru* Samalain were received with signs of doubt. At this juncture our traveller had a happy thought, and drawing from a pocket the flag of Italy, he suddenly displayed it, exclaiming: "This is the flag my Rajah gave me; see, it is different from that of the Dutch; but when it is unfurled Debata (God) is present—you must rise and uncover your heads." The difference was at once noted, and Puttua, the chief who had shown himself most hostile, turned to Modigliani and said, "*Tabi, rajahnami*" ("Hail, my chief"). The others joined, and then two fowls and a pipe were brought to our traveller, and orders given to prepare the *sirih* of welcome and friendship. This is done with special ingredients, the absence of any of which would do away with the sincerity of the offering.

Modigliani was thus allowed to enter the independent Battak country. The next day he resumed his journey towards the east coast. He had to pay for passing a bridge. The Battaks know well the value of money, and use the Spanish dollar divided into 480 *doits* of copper, bearing the date 1804, the British arms, and the inscription "Island of Sumatra" (or the same inscription in Arabic), or else simply a fowl.

Amongst the many interesting things he saw, heard, and learnt, special mention must be made of the magnificent waterfall formed by the emissary of Lake Toba. Modigliani had some difficulty in visiting it, for it is the reputed abode of powerful spirits, or *sombaon*. It is, he says, grand beyond description; all the rivers of the region join the emissary of the lake in the fall, the native name of which is Martua Sapuran Si-arimo: the result is the River Assahan, which flows into the Eastern Sea near Tangion Balei. This is an important geographical discovery, and our friend may well be proud of it. He succeeded in taking a magnificent photographic view of the principal cascade. Two Battak villages, Tanga and Suanan, are on each side of the fall. Modigliani managed to visit both, though hostile to each other, as he learnt, on account of cannibal feats recently committed reciprocally; thus cannibalism is not yet extinct amongst the Battaks. In this trip Modigliani went as far as Bandar Pulo, near the east coast; but not wishing to get into difficulties with the *Controleur* at Tangiong Balei, he turned back towards Toba, taking this time a new route up the valley of the Qualu or Kuwalu River.

The return journey was adventurous, and more than once Modigliani and his small party were in imminent danger. A war expedition of the Dutch had recently been this way, and the depredations and looting of the so-called friendly chiefs and their followers had left behind visible traces, and a burning sense of hate and vengeance against the *sordado* of the Cumponi (Dutch), although nothing can be said against the conduct of the Dutch colonial troops. It required all the energetic persuasions of *guru* Samalain and all the calm courage of Modigliani to avoid hostilities. At the village of Si Buttua, well fortified and in a commanding position, as most are, admittance was gained with difficulty; and matters went worse at the village of Lumban Ballic, where, however, finally Modigliani, as Rajah Rom, was treated with high honours and a dance. His last station was at Hite Tano, the native village of his man Si-gu-tala. Here, after some delay and hesitation, he was treated with friendliness; and to celebrate the return of Si-gu-tala a buffalo was killed, a very grand feast in the Battak country. A good tramp of fourteen hours took Modigliani from Hite Tano back to his log hut in the forest of Si Rambe. He had been away a little more than a month.

Of course, this adventurous trip of Modigliani amongst the independent Battaks got known; the Dutch authorities informed him that he would be expelled if he attempted again to cross into the Battak country, and he found that all his movements were watched and reported by the native police (*opas*). He therefore decided to return to Siboga, where he was on March 14, 1891. He remained there collecting and taking notes until the first days of April, when he proceeded to Bencoolen.

The Geographical Society of Batavia had invited him to explore the island of Engano, and a Government steamer was to convey him there. Modigliani had accepted with delight; but, after waiting some time in vain at Bencoolen for the promised steamer, he decided to start on his own account, and did so, engaging the *prahu* of a Chinaman.

Engano, the furthermost of the interesting islands which guard the western coast of Sumatra, has up to the present date been all but a *terra incognita*. Crawfurd, in his admirable "Dictionary of the Indian Archipelago," gives scant and partly erroneous information on Engano; whilst Vivien de St. Martin, generally so accurate, in his great "Geographical Dictionary," now being issued, says very little, and tells us that the natives are Negritos! And yet Rosenberg visited and explored the island not many years ago. Modigliani, during his stay of over two months, made a thorough exploration of Engano, and of the ways and customs of its natives; and it is indeed fortunate that he went there and gathered such rich ethnological and anthropological materials, for the natives of Engano are rapidly dying out, like those of other savage islands. Ten years ago they were about 8000; now, by the last reckoning of the Dutch Agent, they are reduced to 840!

The natives of this island certainly belong to the great Malayan family. On looking over the photographic portraits taken by Dr. Modigliani, I was forcibly reminded of the Nicobarese; and Modigliani agreed with me on examining the fine series of photographs of natives of the Nicobar Islands in my collection, which I owe to the kindness of my friend, Mr. E. H. Man, Deputy Commissioner of the Andaman and Nicobar Islands, and well known for his exhaustive anthropological researches in those two interesting groups.

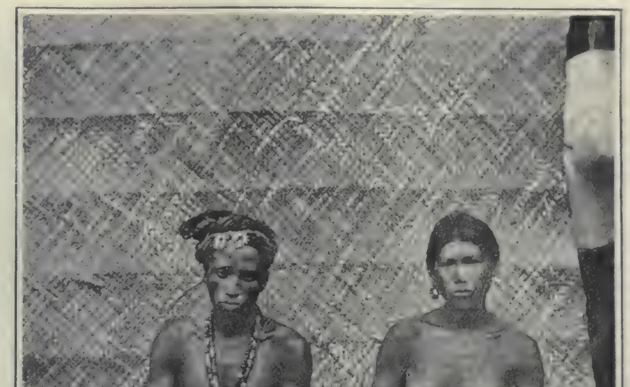

V. TURATI inc.

FIG. 3.—Battak chief and his wife.

Modigliani remained in Engano from April 25 to July 13, 1891. His health, which had hitherto resisted many and various sore trials, was at last injured by the pestilential miasmatic emanations of the mangrove swamps of Engano, and he came away just in time to save his life. At the end of July he embarked at Batavia, and by the end of August we had the pleasure of welcoming him back to Florence.

He has already given brief accounts of his exploration of the Toba country in letters and in two lectures recently delivered at Rome and Florence. He is now busy working out his ethnological materials; those pertaining to zoology have already been partly examined by specialists. The principal novelties in zoology are, as was to be expected, from Engano. Amongst those already published I recall the following:—Birds: *Graucalus enganensis*, *Pericrocotus modiglianii*, *Zosterops incerta*, *Geocichla leucolæma*, *Calornis enganensis*, *Gracula enganensis*, *Carpophaga œnothorax*, and *Macropygia cinnamomea*, are new species from Engano, recently described by Count Salvadori; besides, Modigliani has established the hitherto unknown habitat of a lovely Parroquet (*Palæornis modesta*). Reptiles: *Draco modiglianii*, *Lycosoma relictum*, and *Coluber enganensis* are new species recently described by Dr. Vinciguerra, also from Engano.

On the anthropological and ethnological materials collected by Dr. Modigliani on this voyage, which are many and of great interest, I intend writing a special report, which will be published elsewhere. I will therefore, in concluding this communication, merely draw attention to their scientific value, mentioning the more important series.

Amongst the Toba Battaks, Modigliani was not successful in obtaining human skulls, but, with the help of *guru* Samalain, he was able to take with rare ability and perfection a magnificent series of plaster masks of the face from life, both of men and women. He has made, besides, a splendid collection of photographs illustrating the people and their habits. A most extensive and perfect series of actual specimens and carefully constructed models made on the spot illustrate completely the houses, *sopos*, and boats, with their ornaments; the agricultural implements, house furniture, dress and personal ornaments; food and stimulants, with the utensils pertaining thereto; work-tools, and weapons offensive and defensive; religion and superstitions, witchcraft and literature. The carvings on the houses, and the patterns of the textile fabrics of the Toba Battaks, are indeed remarkable as specimens of the finest style of ornamentation. Amongst the numerous series illustrating the crude religion and manifold superstitions of this singular people, I may mention the carved wooden figures, with movable arms and a square hole in the chest, in which is the sacred relic (*pangulubalang*) or talisman containing part of the remains of a sacrificed child; these figures, of which Modigliani has collected quite a number, are as rudely made as the *karwars* of North-west New Guinea. Of the remarkable magic staffs, called generically *tungal pagñaluan*, but which appear to have individual names, Modigliani has secured seven; they consist of superposed figures, more or less conventionalized, but beautifully carved in a hard dark wood in most cases, in which the human figure and those of the elephant, buffalo, lizard, and serpent are variously entwined. Modigliani thinks that each of these staffs symbolizes the history of the village or clan to which it belongs, in which case they might be compared to the genealogical Maori staffs, like the one recording the history of the Ngatirangi tribe, now in the British Museum. As samples of the little-known literature of the Battaks, Modigliani was fortunate enough to secure twenty of their books, now rare. They are ancient-looking tomes of various sizes, bound in wooden boards; the leaves are of beaten bark, the writing minute, mystic figures (*hatiha*) being occasionally intercalated. These books, written by learned *gurus*, are of a sacred, medicinal, and encyclopædic nature, and much very valuable information on the Battaks will certainly be gained by their translation.

At Engano, Modigliani was able to obtain three skulls, and took six excellent plaster casts from the living. His series of photographs is also fine; but unfortunately some of the best were spoiled by the heat. I have already noted the remarkable resemblance which the natives of Engano show with those of the Nicobar Islands. There are amongst them faces which also recall Polynesian and especially Micronesian types. Thus the photographs taken by my friend, over a hundred, are of great ethnological value. The collections illustrating the ethnography of the Engano islanders are, I should say, complete: besides beautiful models of the singular houses and canoes, and actual specimens of the ornamented portions, viz. doors, cross-seats, &c., the mourning and ceremonial dresses and ornaments, house utensils, weapons, &c., are represented by a great number of carefully selected specimens.

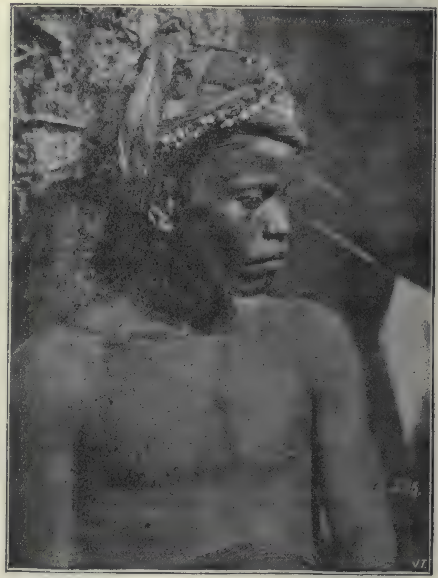


FIG. 4.—Battak gentleman.

In conclusion, I can only say that Dr. Modigliani has done much excellent work, and that we may look forward with pleasure to the publication of the results of his investigations, both in zoology and in anthropology.

HENRY H. GIGLIOLI.

A MODERN REVIVAL OF PROUTS HYPOTHESIS.[1]

IT frequently happens in the history of science that the line of thought engendered by one branch of study proves applicable in a totally distinct field. In accordance with this principle a great stimulus is occasionally given in some particular line of research by the encroach-ment of an investigator who brings the vitalizing ideas derived from his own work to bear upon a new subject. It was with some such notions as these that we were predisposed to welcome Mr. Wilde's attempt to deal with the greatest of all the problems presented by modern chemistry, but a careful consideration of the author's views has, we regret to say, left us in a state of disappointment for reasons which we will endeavour to explain to the readers of NATURE.

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[1] "On the Origin of Elementary Substances and on some New Relations of their Atomic Weights." By Henry Wilde, F.R.S. (London: Kegan Paul, Trench, Trübner, and Co., 1892.)

The work under consideration is a quarto pamphlet of eighteen pages and a folding table giving the author's and other arrangements of the chemical elements. It consists of a preface dated May 1892, and a paper reprinted with additional notes from the Memoirs of the Manchester Literary and Philosophical Society for 1883 and 1887, the results having been first made known in the Proceedings of the same Society for April, 1878. The preface and paper are followed by translations of the same into French. Everything emanating from a recognized authority in a distinct department of science is worthy of consideration by chemists, and there are scattered throughout the work many statements which we cannot but endorse. There are, moreover, a few suggestions here and there which might be fruitful, and although the general result is disappointing, it is opportune that the author should have restated his hypothesis at a time when all chemists have more or less assimilated the views of Newlands, Mendeléef, Lothar Meyer, and their followers. It may be stated at the outset that Mr. Wilde's theory has nothing to do with an electrical origin of the elements as his reputation as an electrician might at first lead us to imagine.

In very brief terms the author's theory is that the elements have been evolved from hydrogen by a process of nebular condensation. In so far as he regards the elements as polymerides (as we might now express it) of hydrogen, there is nothing new in the idea. It is Prout's hypothesis pure and simple. We are far from asserting that this hypothesis has been disproved; there is a fascinating simplicity about it—it is so much in harmony with the general course of nature that matter should have been evolved from some primordial stuff that we should like it to be true; but unfortunately the most exact determinations of atomic weights have in later times not always conformed to the requirements of the hypothesis. Mr. Wilde in effect, if not in words, says *tant pis pour les faits!* These numbers ought to be whole multiples of the atomic weight of hydrogen, and Mr. Wilde unhesitatingly makes them so. In some cases the discrepancy between the observed atomic weights and those calculated from the theory is so great—apart from the doubling or other manipulation of some of the old numbers—that this alone will damage his case in the eyes of those who know the scrupulous care taken and the variety of methods resorted to in order to secure purity of material in such determinations. We give a few examples:—

	Accepted Atomic Weight.	Calculated.		Accepted Atomic Weight.	Calculated.
Cu	63·18	62	Cr	52·45	54
Be	9·08	8	W	183·6	186
Sc	43·97	42	Si	28·2	35
Ga	69·9	96	Ni	58·6	56
Y	88·9	123	Co	58·6	56
In	113·6	150	Ir	192·5	196
Ta	182	185	Os	191·12	196

A large number of atomic weights not given above differ by one unit from the experimental results; in fact, more than half the existing determinations are in the light of the present theory erroneous to a most humiliating extent.

We are not bigoted in our faith respecting the unassailable accuracy of the determinations of these constants; we all know the enormous difficulties which meet the chemist in his attempts to obtain his compounds in a state of purity. In one part of his paper the author suggests "that slight differences in the determinations may arise from the latent affinity which some elements have for minute quantities of another," which is a reasonable supposition in its way, although not very happily expressed. But later he somewhat inconsistently remarks "that these discrepancies are due to . . . some unknown cause which prevents their [*i.e.* Cu, Zn, &c.] true atomic weights from being ascertained."

From a purely philosophical standpoint the author's proposed emendations of the atomic weights are perfectly legitimate. If it can be satisfactorily proved that these constants are the numerical consequences of some general law requiring that the relative combining weights referred to hydrogen should be whole numbers, it is correct to conclude that our determinations are, through experimental error, difficulty of separation, &c., faulty. That some such law exists has been surmised again and again, but unfortunately the proof has not yet been found. Now the central idea of Mr. Wilde's paper is that there is an analogy between Bode's law of the planetary distances and the numerical relationships between the atomic weights, and he even attempts to show that this analogy is the result of a causal connection between the phenomena. This is the most important suggestion in the work, as the whole novelty centres in this idea, and the subsequent acceptance of his views will turn upon the strength of his case in demonstrating these two points: first, that Bode's "law" is the expression of a physical reality; and, secondly, that the numerical relations between the atomic weights are the physical expressions of a causal connection between the distances of the planets and the condensation of the primordial matter (? hydrogen.)

The first point is purely astronomical, and we prefer to let astronomers speak on the subject. Prof. Simon Newcomb says ("Popular Astronomy"):—

> It is true that many ingenious people employ themselves from time to time in working out numerical relations between the distances of the planets, their masses, their times of rotation, and so on, and will probably continue to do so; because the number of such relations which can be made to come somewhere near to exact numbers is very great. This, however, does not indicate any law of nature. If we take forty or fifty numbers of any kind—say the years in which a few persons were born; their ages in years, months, and days at some particular event in their lives; the numbers of the houses in which they lived; and so on—we should find as many curious relations among the numbers as have ever been found among those of the planetary system.

The author thus gets but little support from astronomy and it is to be observed that in the list of planetary distances which he gives he stops short at Uranus; Neptune occupies an awkward position for Bode's "law." The flight which is taken in connecting this "law" with the atomic weights is, however, a bold one and worthy of being given in the author's own words. After stating the nebular hypothesis he says:—

> That this gaseous or primordial substance consisted of a chaotic mixture of the sixty-five elements known to chemists is a notion too absurd to be entertained by any one possessing the faculty of philosophic thinking, as the regular gradation of properties observable in certain series of elements clearly shows that elementary species are not eternal, but have a history, which it is the proper object of physical science to unfold.

With this we most cordially agree, and as the same idea has been repeatedly expressed by chemists and physicists, we do not imagine that it is likely to be controverted. Then he continues:—

> One of the principal facts which, to my mind, establishes the nebular theory of the formation of planetary systems on a firm basis is Bode's empirical law of the distances of the members of the solar system from each other and from the central body, as in this law is comprehended the idea of nebular condensation in definite proportions. Now, if elementary species were created from a homogeneous substance possessing a

> capacity for change in definite proportions, it is probable that the greater number of elements would be formed during or after the transition of the nebular matter from the annular to the spheroidal form. Moreover, as great cosmic transitions are not made *per saltum*, it might be expected that some modification of the law of nebular condensation into planetary systems, as exhibited in Bode's law, would be found on the further condensation of the primitive matter into elementary species.

There appears to be a flaw in this chain of reasoning which weakens the whole paragraph. It is difficult to see how a law, which the author himself describes as "empirical," can establish a theory on a "firm basis." We admit that an empirical law may be of use—Bode's law is a case in point—but surely it must pass beyond the stage of empiricism before it can establish anything on a firm basis. The astronomical foundation having therefore been shown to be insecure, or, in the opinion of astronomers, even non-existent, it remains next to consider the second point, with respect to which we shall let the author speak for himself:—

> One objection raised against the theory which I have propounded on the origin and compound nature of the elements I will remark upon, is an alleged want of causal connection between the series of planetary distances and a series of atomic weights. Now, considering that specific gravities and atomic weights are admittedly correlated properties of the elements, and that specific gravities are fundamentally correlated with the dimensional properties of space, it follows that planetary condensations within interplanetary space are correlated directly with atomic condensations and atomic weights within that space. Hence the law that every increase of atomic weight, in a well-defined odd or even series of elements, is attended by an increase of specific gravity, is a natural consequence of the theory.

This is quoted from the preface; the mechanism of the process is described in the paper as follows:—

> In the present hypothesis it is assumed:—(1) That a mass of hydrogen, of a curvilinear form, acquired a motion of rotation about a central point, which caused it to take a spiral or convolute form. (2) As each successive spiral or convulution was formed, the particles of hydrogen combined with themselves, as far as the septenary combination, to constitute the type of each series of elements—the number of types or series being equal to the number of convolutions of the rotating gas. According to this view, the elementary groups may be represented as forms of Hn, H2n, H3n, H4n, H5n, H6n, H7n; the internal convolutions forming the highest type, H7n, and the outer convolution the type Hn. (3) That on a further condensation of the elementary matter a transition from the spiral to the annular form occurred, during or after which the series under each type was generated in concentric zones and in the order of their atomic weights, until the highest member of each species was formed. (4) That as the elementary vapours begin to condense, or assume the liquid form, their regular stratification would be disturbed by eruptions of the imprisoned vapours from the interior of the rotating mass. The disturbance would be further augmented by the subsequent combination of the negative with the positive elements, and also by the various solubilities of their newly-formed compounds; so that the evidence of such stratification of the elementary vapours as I have indicated must necessarily be more fragmentary than that of the geological record.

In support of this last statement the author mentions the well-known association of allied elements in minerals.

The idea of an evolution of matter by a process of nebular condensation as above set forth is to be found under various forms in the writings of Herbert Spencer, of Sterry Hunt, Lockyer, and others. Also, it may be remarked in passing, that the hypothesis of stratification in the order of density was applied to the sun by Johnstone Stoney about the year 1867. In fact the general notion of elementary evolution is so obvious that it cannot fail to present itself again and again to those who think over such problems as are here dealt with. For the sake of chemical philosophy we only wish that this speculation could be placed on a firmer basis of observation or experiment—if for no other reason in order that the minds of chemists might be cleared of this inorganic *Urschleim* in which since the time of Prout they have been compelled to wallow.

Reduced to its ultimate terms it will appear, then, that Mr. Wilde's view is a combination of the nebular with Prout's hypothesis, the latter being stated with a precision and boldness which certainly goes beyond any utterance on this subject to be met with in chemical literature since the time of its promulgation. Although the author takes hydrogen as the first stage in his evolutional series he admits, with Prout, that this element "may have been evolved from an ethereal substance of much greater tenuity." Under the seven stages of condensation comprised from Hn to H7n. The author arranges all the chemical elements in a tabular form, leaving gaps for unknown elements, and correcting the atomic weights where necessary so as to make them accord with the hypothesis. Some of the results of this treatment have already been alluded to. The way in which Bode's method is applied will be understood by taking one example, viz. the first series, Hn:—

0 0 7 = Li = 7
1 × 23 − 0 = Na = 23
2 × 23 − 7 = K = 39
3 × 23 − 7 = Cu = 62
4 × 23 − 7 = Rb = 85
5 × 23 − 7 = Ag = 108
6 × 23 − 7 = Cs = 131
7 × 23 − 7 = — = 154
8 × 23 − 7 = — = 177
9 × 23 − 7 = Hg = 200

The rule of construction is: multiply the atomic weight of the second member (Na = 23 in the above) by the arithmetical series and subtract the atomic weight of the first member (Li = 7 in the above) from the products; the results are the atomic weights of the elements of the series. This method is applied also to the group H2n with tolerable success, *provided the atomic weights are modified to even numbers and that the atomic weight of beryllium is made* 8. Mr. Wilde's second group is given below:—

Be, 8; Mg, 24; Ca, 40; Zn, 64; Sr, 88; Cd, 112; Ba, 136; *x*, 160; *x*, 184; Pb, 208.

This is presumably one of the new relations between the atomic weights referred to in the title of the paper. In the third group, however (H3n), very considerable modifications of the atomic weights have to be made, as will be seen from the author's results:—

C, 12; Al, 27; Sc, 42*; Ce, 69*; Ga, 96*; Y, 123*; In, 150*; Er, 177*; Tl, 204; Th, 231.

The six numbers marked with an asterisk stand for 44; 92 or 141; 70; 61·7 or 89·5; 75·6 or 113·4; and 170·6 respectively. A system which necessitates this amount of manipulation of experimental results will certainly fail to commend itself for adoption by chemists. The proposed change of beryllium from 9·2 to 8 is directly opposed by the determination of the vapour density of the chloride by Nilson and Pettersson, and if adopted would cause this element to become still more divergent from the law of Dulong and Petit. The vapour density of indium chloride as determined by Nilson and Pettersson is in accordance with the accepted atomic weight of that element and opposed to that given by Mr. Wilde. The elements associated in the first and second groups respectively, may be allowed to pass as natural allies, but the separation of carbon from its analogues, silicon, titanium, &c., and its association in the third group with aluminium, scandium, gallium, &c., is a violation of known relationships. The four halogens according to their atomic weights belong to the author's first (Hn) group. They are regarded as the negative analogues of the alkaline metals and are therefore placed in a separate column in such a way as to bring out the relation that there is a constant difference of 4 between each halogen and its positive analogue :—

Na, 23 – 4 = 19, F ; K, 39 – 4 = 35, Cl ; Rb, 85 – 4 = 81 Br ; Cs, 131 – 4 = 127, I.

In a similar way the oxygen group is made into a negative column having positive analogues in the H2n group and showing a constant difference of 8 :—

Mg, 24 – 8 = 16, O ; Ca, 40 – 8 = 32, S ; Sr, 88 – 8 = 80, Se ; Ba, 136 – 8 = 128, Ta.

Of course chemists have long been familiar with various numerical relationships between groups of allied elements, but this does not appear as sufficient evidence for altering the atomic weights of Br, Cl and Se, unless these relationships can be conclusively shown to be the necessary result of a general law.

But apart from such defects as have been pointed out, it will be seen that the proposed grouping breaks down altogether after the third group. The author is hardly fair when he says (Preface, p. iv.) :—"While the multiple relations subsisting among the atomic weights of the other series of elements are highly interesting, they do not possess, in the present state of our knowledge, that degree of precision which is the distinguishing feature of the series Hn and H2n. An exception might, however, be made in favour of the series H3n, &c."

As a matter of fact it is not a question of "degree of precision" at all, for, as far as we can see, the other groups do not lend themselves to the Bodeian method ; at any rate, not in the form applied to the groups Hn, H2n, and H3n. We give the author's results as compared with those obtained by the application of his own method :—

Group H4n.

x = 16 ; x = 32 ; Ti = 48 ; Ge = 72 ; Zr = 92 ; Sn = 116 ; La = 140 ; x = 164 ; D = 188 ; U = 240.

The numbers obtained by the rule (1, 2, 3, 4, &c. × 32, and 16 subtracted from each product) are 32, 48, 80, 112, 144, 176, 208, 240, &c., which, after Titanium, do not represent any atomic weights in the group till Uranium is reached.

Group H5n.

B = 10 ; P = 30 ; V = 50 ; As = 75 ; Nb = 95 ; Sb = 120 ; x = 140 ; x = 165 ; Ta = 185 ; Bi = 210.

Calculated (1, 2, 3, 4, &c. × 30 and 10 subtracted from each product) the numbers are :—30, 50, 80, 110, 140, 170, &c.

Group H6n.

x = 18 ; x = 36 ; Cr = 54 ; Mo = 96 ; x = 144 ; W = 186.

Calculated (1, 2, 3, 4, &c. × 36 and 18 subtracted from each product) the numbers are :—36, 54, 90, 198, &c.

Group H7n.

N = 14 ; Si = 35 ; [Fe = 56 ; Mn = 56 ; Ni = 56 ; Co = 56] ; [Pd = 105 ; Rh = 105 ; Ru = 105 ; Da = 105] ; [Au = 196 ; Pt = 196 ; Ir = 196 ; Os = 196].

Calculated (1, 2, 3, 4, &c., × 35 and 14 subtracted from each product) the results are :—35, 56, 91, 126, 161, and 196.

The association of nitrogen with silicon and the metals of the iron and platinum groups is, to say the least of it, incomprehensible. We have thought it desirable to give this analysis, for no reason is given in the paper for this particular grouping after the third series, beyond the well-known chemical relationships of the elements which, as we have seen, is sometimes violated in a most unaccountable way. The groups are obviously not constructed by the Bodeian method ; the atomic weights are modified in many cases by one or two units, and the result is a classification which differs only from the received classification on points which cannot possibly be conceded by chemists. The reason why silicon is separated from its analogues is as follows :—

> Now, if silicon were the true analogue of titanium, the oxides of these elements should be isomorphous, whereas the crystalline form of quartz is hexagonal, while rutile, anatase, brookite, zirconia, and tinstone (similar oxides of members of the series H4n) are tetragonal ; consequently, silicon does not belong to the series H4n.

This is a point, and out of justice to the author we give it for what it is worth,[1] but the atomic weight of silicon has been determined by the vapour density of its chloride, and the result is fatal to Mr. Wilde's classification. His attempt to justify the atomic weight 35 by an appeal to the specific heat is unfortunate, because he takes the old determination by Regnault (0·176) instead of the more recent determination by Weber (0·203 at 230° C.). Moreover, he is inconsistent in not allowing the same correction for boron and the other elements which deviate from Dulong and Petit's law.

We cannot go much further into the details of this paper. Enough has been written to justify the disappointment which we expressed at the outset, and it is only the intrinsic importance of all questions bearing upon the origin of the elements that has warranted such extended treatment. It appears that the numerical relations which are brought out by the author's method have either long been known or else—as in his application of the Bodeian method—they do not exist beyond a limited number of groups. The results do not take us beyond the point at which chemists were left by Döbereiner, Pettenkofer, Dumas, and numerous other chemists who, for three-quarters of a century, have directed attention to such numerical relationships. In some respects—such, for example, as in the exactness with which the atomic weight of an element is the arithmetical mean of the elements above and below it in the same series—Mr. Wilde's numbers express the relationship more closely than those of any other author ; but this agreement is simply brought about by forcing the atomic weights into the requirements of the case. The increase in density as the odd and even series are ascended, is nothing more than an imperfect way of stating the well-known relationship between atomic weight and atomic volume, which is so much better shown by Lothar Meyer's curves. The table of elements presented by Mr. Wilde ignores that fundamental principle of periodicity or recurrence of properties which is the key-note of Mendeléeff's system, and which has led to the general adoption of that system by chemists. We do not pretend that Mendeléeff's classification is faultless ; the illustrious founder of the Periodic Law would be the first to admit that his system has certain imperfections. Mr. Wilde has emphasized a few of these in his preface, and he somewhat summarily dismisses the whole scheme in the following words :—

> From the numerous discrepancies which present themselves in the classification of the elements when arranged in the regular order of their atomic weights, it will be obvious that the idea of recurring properties or periodic functions, in terms of the vertical series of Newlands or the horizontal series of Mendeléeff, has no more relation to chemical science than the law of the increase of population, or the laws of variation and inheritance in organic species.

This paragraph, penned in the present year, will, perhaps better than any other statement that could be reproduced from the paper, enable chemists to form a correct estimate of the value of the work and of the author's qualifications for dealing with the question of the origin of the chemical elements.

R. MELDOLA.

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[1] "Stannic and titanic oxides resemble silica both physically and chemically . . . . . they might be expected to form analogous compounds, and be isomorphous with silica, as Marignac (1859) found actually to be the case." Mendeléeff's "Principles of Chemistry," vol. ii. p. 95.

NOTES.

BY the death of Lord Tennyson not only does England lose one of her noblest sons, but the world loses the Poet who, above all others who have ever lived, combined the love and knowledge of Nature with the unceasing study of the causes of things and of Nature's laws. When from this point of view we compare him with his forerunners, Dante is the only one it is needful to name; but although Dante's knowledge was well abreast of his time, he lacked the fulness of Tennyson, for the reason that in his day science was restricted within narrow limits. It is right and fitting that the highest poetry should be associated with the highest knowledge, and in the study of science, as Tennyson has shown us, we have one of the necessary bases of the fullest poetry—a poetry which appeals at the same time to the deepest emotions and the highest and broadest intellects of mankind. Tennyson, in short, has shown that science and poetry, so far from being antagonistic, must for ever advance side by side. We are glad to know that the Royal Society, of which Lord Tennyson has been for many years a Fellow, was fittingly represented at his funeral by its President and officers.

WE regret to announce the sudden death of Mr. Robert Bullen, the curator of the Glasgow Botanic Gardens. He was well known as a horticulturist, being especially successful in the cultivation of orchids. The post vacated by his death is one of the best of the kind in the country, and we understand that the appointment will rest with the Corporation of Glasgow, who took over the management of the Botanic Gardens in 1891.

THE death of Dr. Léon Poincaré, professor in the Faculty of Medicine at Nancy, is announced. He died on September 15 at the age of sixty-four.

AT the meeting of the Linnæan Society of New South Wales on August 31, Mr. H. Deane, Vice-President, who occupied the chair, referred to the loss the Society had sustained by the death of Mr. R. D. Fitzgerald, well known for his knowledge, and for his artistic delineations, of Australian orchids.

RUSSIA, which already possesses some of the best equipped chemical laboratories in Europe, is to have another which is to eclipse all others. On September 13/25 the foundation stone of the new chemical laboratory of the University of St. Petersburg was laid with befitting ceremony. The new laboratory, which is designed by Prof. Mentschatkin in collaboration with the architect Krassowsky, is based upon the best existing models in Germany and Austria.

IN the *Times* of the 10th inst. there is an announcement that Surgeon-Major Laurie has proved that the fall of blood-pressure in animals rendered insensible by chloroform is due to the action of the anæsthetic on the brain, and not on the heart. When blood containing chloroform is allowed to reach the brain only all the ordinary phenomena of anæsthesia are observed, but when such blood is conveyed to every other part of the body except the brain, which, by a peculiar arrangement of the experiment, is supplied with pure blood, the anæsthetic effects of chloroform and also its depressing effects on the circulation are not observed. We are glad to see that Dr. Laurie is still continuing his experiments on a subject of such vital interest, and we trust that his energy and the generosity of the Nizam, to which we owe the elaborate work of the Hyderabad Chloroform Commission, will meet an ample reward.

THE British Ornithologists' Union, founded in 1858, consists of upwards of 250 votaries of this branch of natural history, who maintain as their organ the well-known ornithological journal, *The Ibis*, now in its thirty-fourth volume. The more active members of the union have just formed themselves into a club, and will meet together once a month to read and discuss papers and to exhibit specimens. The first meeting of the "British Ornithologists' Club" will be held on October 19. Mr. Howard Saunders, F.Z.S., is the treasurer and secretary.

THE university of Padua is about to hold a festival in honour of Galileo. The seventh of December, 1892, will be the tercentenary of the day upon which Galileo ascended the chair of mathematics at that university. In the words of the letter of invitation which the rector, Prof. Carolus Ferraris, has just issued to some of the learned societies of Europe, "Illo enim die Ann. mdxcii. summus acerrimusque investigator legum, quibus caelestium terrestriumque rerum natura continetur, hic cathedram ascendit eamque voce sua immortalitati commendavit." It is to the honour of Padua that it welcomed Galileo to this high position the very next year after he had been publicly hissed and obliged to resign his professorship at Pisa. The festival will extend from the 6th to the 8th of next December.

THE Linnæan Society of New South Wales has just issued a second circular with respect to the Macleay Memorial Volume by which it appears that only £170 has been contributed out of £400 which is required for the publication of the Memorial Volume. The circular calls to mind Sir William Macleay's contributions to science, in purchasing and fitting out at his sole expense the ship *Chevert* and exploring the island of New Guinea, and in presenting to the University of Sydney his entire collection valued at £23,000, together with £6000 to provide salary for a curator. Sir William Macleay was also the founder of the Linnæan Society of New South Wales, for which he erected a suitable building, and which he endowed with the sum of £20,000. He further founded a chair of bacteriology and four scientific fellowships at the University of Sydney, at a cost altogether of £47,000. The sum of £170 seems hardly adequate as a recognition of these munificent gifts to science, to say nothing of the original researches which Macleay himself conducted.

MR. THOMAS HODGKINS, of Long Island, New York, has sent to the Royal Institution no less than £20,000 for the promotion of scientific research. Not very long ago, as we noted at the time, Mr. Hodgkins presented £40,000 to the Smithsonian Institution at Washington.

THE Severn Valley Field Club has completed the work of the current year. It has paid some attention to the glacial deposits at Gloppa, near Oswestry, which have recently yielded to Mr. A. C. Nicolson a large series of fossils. The members have also visited the Triassic rocks of the area round Warwick. Their work concluded with an investigation of the Uriconian and Longmyndian formations of Western Shropshire under the guidance of the President, Dr. C. Calloway.

DR. J. M. MACFARLANE has been appointed to the chair of Biology in the University of Pennsylvania, Philadelphia. He formerly held the post of senior assistant in the Botanical Department of the University of Edinburgh.

AN influential association has been formed for the promotion of the study of the Hausa language and people, in commemoration of the services of the Rev. J. A. Robinson, who died last year at his work as a missionary in the Niger Territories. Hausa is the *lingua franca* of the Central Sudan, extending from the Sahara to the tribes near the Gulf of Guinea, and from the Egyptian Sudan to the French colony of Senegal. Mr. Robinson convinced himself that no satisfactory work of any kind could be carried on among the races of the Central Sudan without a knowledge of Hausa. The Executive Committee of the new Association have decided to endeavour, with the least practicable delay, to appoint two "Robinson Students," conversant with Arabic or Hebrew, whose preliminary labours would be carried on in the comparatively temperate climate of Tripoli, with a view to their proceeding at a later date to the Central Sudan, where they would make the language and customs of the Hausas subjects of careful study. All scientific observations collected by these students during their residence in Africa will be sent to the Association for distribution to the appropriate societies.

THE Association of American Agricultural Colleges and Experiment Stations will hold its sixth annual convention at New Orleans on November 15. The different subjects assigned to station workers for the Columbian Exhibition will be discussed.

PROF. H. MARSHALL WARD, F.R.S., of the Royal Engineering College, Cooper's Hill, will give a course of ten lectures at University College, London, on "The Morphology and Physiology of Fungi and Schizomycetes." The course will begin on Thursday, October 13, at 3 p.m., and be continued at the same time each week till Christmas.

A LARGE plant of *Fourcroya* is now in flower in the conservatory of the Royal Botanic Society. The secretary of the Society referred to it at the meeting of the Council on Saturday last. The plant is sometimes called the century plant, the idea being that it flowers only once in a hundred years. In reality the flower is produced only once in the life of the plant, the duration or term of life varying considerably, according to the treatment the plants individually receive. Specimens of the *Agave Americana* have flowered in the Royal Botanic Society's garden, the ages of them being well authenticated as over 80 years; but the plant is known to flower in warmer climes before twenty years of age. The present specimen of *Fourcroya* is between twenty and thirty years old. It began on August 1 last to produce its flower spike, which, although the plant is slow growing generally, developed at a rapid pace, so that on September 15 the tip had reached the glass roof. A square of glass being removed, the flower spike continued its growth, and it is now some 3 feet or 4 feet above the ridge, a total of over 30 feet in height. The leaves vary from 6 feet to 7 feet in length.

IN his treatise, "On the Propagation of Electric Force," Prof. Hertz mentions some experiments tending to prove that the production of resonance and the period of oscillation in resonators are not influenced by the specific resistance or the magnetic properties of the secondary conductor. But if the phenomena be observed electrometrically, the individual properties of the metals soon show themselves. This method was employed by Mr. V. Bjerknes, of the University of Christiania, who gives an account of his results in No. 9 of *Wiedemann's Annalen*. Experiments made with copper, brass, German silver, platinum, nickel, and iron show that metals have different powers of absorbing the energy of electric waves. The rate of absorption increases with the resistance and with magnetization of the metal. Iron and nickel were able to follow the oscillations to a certain extent, which means that their magnetization was actually reversed one hundred million times per second.

A method of exhibiting the Hertzian oscillations to a large audience is described in the same number by Mr. L. Zehnder, of the University of Freiburg. The two conducting rods placed in the focal line of the concave mirror are connected with a Geissler tube, within which the ends are placed very closely together, but so that a discharge produces not a spark but a general luminosity inside the tube. The secondary Hertz effects are too feeble to be visible except at a very short distance and in a darkened room. In this case they are augmented by a kind of relay. On either side of the terminals of the resonator are two other terminals from a circuit of 600 secondary cells, which can be regulated so that the current is just unable to traverse the distance between the terminals. As soon, however, as the resonator responds to electric oscillations, the relay is brought into action, and a brilliant discharge takes place. In cases where such a large accumulator is not available, it is possible to work with another inductorium, or, still better, to obtain the oscillating current from the primary coil by bringing one end of a wire into its neighbourhood, the other being led to earth. By such means it is possible to exhibit the phenomena in question without even darkening the room.

THE weather during the first part of the past week was very boisterous and inclement over the whole of these islands. Between Thursday, the 6th inst., and Monday last, two deep depressions closely following each other passed over the country from off the Atlantic, and heavy gales were experienced in all parts of the United Kingdom, accompanied by much rainfall, while thunderstorms and hail occurred in many places. The sea also was exceptionally rough, especially on our north-west coasts, and caused much damage on shore. Temperature was somewhat low for the time of year, the daily maxima rarely reaching 60° in any part, while the nights were very cold. As the depressions passed to the eastward the weather cleared and the temperature decreased considerably, sharp frost occurring on the ground over the inland parts of England. Towards the close of the period the type of weather was becoming more settled in character than it had been for some time past, but on Tuesday a depression lay over the Bay of Biscay, which might disturb our conditions. The *Weekly Weather Report* of the 8th inst. showed that during that week the rainfall exceeded the mean in all districts except the south of Ireland, and that temperature was from 2° to 4° below the mean, the lowest of the minima ranging from 32° to 38°. The only district in which bright sunshine exceeded the mean was the Channel Islands; the percentage of the possible duration amounted there to 40, while it was only 8 in the north of Scotland.

THE Meteorological Council have published the hourly means obtained from their self-recording instruments at four observatories for the year 1889, for periods of five days, calendar months, and for the year, while means of pressure and temperature and totals of rainfall are also given for every day. This is the third year in which the observations have been published in this form, instead of the actual hourly values, as formerly, and an addition has been made by including the monthly and yearly mean values of the daily maximum and minimum temperatures for this and the two previous years in this volume. The work contains 112 quarto pages of very clearly drawn-up tables.

MR. H. DEVAUX has been making interesting experiments on the sense of taste in ants. Among other results he has found that *Lasius flavus*, while fond of sugar, dislikes saccharine. The ants swarmed around sugar laid out for them, but turned away from saccharine as soon as they tasted it. Even sugar became unpleasant to them when it was mixed with saccharine. It seems, therefore, that sweetness is not the only quality which attracts them to sugar.

PROF. SCOTT has a note in the new volume of "the Transactions and Proceedings" of the New Zealand Institute, on the occurrence of cancer in fish. The fish afflicted with this disease were all specimens of the American brook-trout (*Salmo fontinalis*) kept in confinement in one of the ponds at Opoho belonging to the Dunedin Acclimatisation Society. Males and females were alike affected, and the diseased fish never recovered. Prof. Scott has been able to examine several specimens showing the disease in various stages of advancement, and gives in his paper a short account of the naked-eye and microscopic appearances of the growth. The occurrence of cancer in the lower animals has been frequently observed of late years, and it is by no means so rare among them as it was at one time thought to be. Prof. Scott does not, however, know that it has ever before been noted in fish.

In his report as surgeon-naturalist of the Marine Survey of India, to which we referred last week, Dr. A. Alcock records some interesting observations on the little estuarine crab *Gelasimus.* The most obvious structural peculiarity of *Gelasimus* is the enormous development of one of the chelæ in the male only, the chelæ in the female being minute. The species observed by Dr. Alcock was *Gelasimus annulipes,* Edw. This species lives in vast swarms in "warrens" on the muddy tidal swamps of the Godávari and Kistna, each individual having its own burrow, round which it ranges, and into which it retreats when alarmed. In the colder months, at any rate, the males far outnumber the females. In a fully adult male the length of the large chela is two-and-a-half times the greatest length, and one-and-a-half times the greatest breadth, of the whole body, and 40 per cent. of the entire weight of the animal, and is coloured a beautiful cherry-red fading to a rose pink, the rest of the animal being of a dingy greenish-brown colour. Dr. Alcock has been able to observe that, whatever other functions the great chela may serve, it also, in the species under consideration, is (1) a club used in the contests of rival males, and (2) a signal to charm and allure the females. This last function is particularly apparent. As one walks across the mud one first becomes aware of the presence of these crabs by noticing that the surface of the mud is everywhere alive with twinkling objects of a brilliant pearly-pink colour. Carefully watched, these prove to be the enormous chelæ of a crowd of males of *Gelasimus* waving in the air, each little crab standing at the mouth of its burrow and ceaselessly brandishing its big claw. On closer observation, among every ten or so males a small clawless female may be seen feeding in apparent unconcern. If the female should approach the burrow of a male, the latter displays the greatest excitement, raising itself on its hindmost legs, dancing and stamping, and frantically waving its beautifully-coloured big claw. From prolonged watching, Dr. Alcock feels convinced that the waving of the claw by the male is a signal of entreaty to the female, and he thinks that no one can doubt that the claw of the male has become conspicuous and beautiful in order to attract and charm the female. The second function, as a fighting weapon, becomes apparent when in the general tournament one of the rival males approaches too close to another. The great claw is then used as a club, the little creatures making savage back-handed sweeps at each other.

An excellent paper on fungous diseases and their remedies was read lately by Prof. J. E. Humphrey before the Massachusetts Horticultural Society, and has now been printed. One of the principles on which he insists is that the treatment of these diseases, to be efficient, must be preventive rather than remedial. He points out that it is not enough to take care that plants shall have abundant nourishment. No practice, he says, is more common among American fruit growers than to leave in the vinery and the orchard, lying on the ground or hanging from the branches, the dead fruits of the season, which have been rendered worthless by fungi. Nothing could produce more unhealthful conditions, for these dead fruits commonly furnish to the fungi which attack them precisely the most favourable soil for further and complete development. In the next spring the air is full of the spores of these fungi, which find lodgment on the new leaves and fruits of the very plants on which they grew last year; and so the story goes, year after year. "In a word," says Prof. Humphrey, "keep your orchards and gardens and greenhouses *clean.* Allow no rubbish to be about on which fungi can breed. Remove and destroy all diseased fruits or plants as scrupulously as you preserve saleable ones, and you will have more saleable ones to preserve. It is surprising how far generous culture and clean culture will go toward preventing fungous diseases, without special treatment."

The Marquis de Nadaillay contributes to *Science* (Sept. 23) an interesting account of the various discoveries which have been made in the caves of Baoussé Roussé, between Mentone and Ventimiglia. The caves were found in 1872 by M. Rivière, who has since vigorously prosecuted his excavations. These have yielded many human skeletons, all belonging to the Cro-Magnon race. They are robust, and bespeak an athletic constitution and great muscular power. The men were remarkably tall, the crania are dolichocephalic, and the tibias platycnemic. The bones of all the adults, after the total decomposition of the flesh, were painted red with the help of peroxide of manganese or other substances frequently met with in the caves: a custom which the Marquis de Nadaillay believes prevails, or till lately prevailed, among some Indian tribes. Much attention has been devoted to the latest discovery, made early in the present year, of three skeletons—a man, a woman, and a "young subject," whose wisdom teeth had not been developed. They were found eight metres below the ground, and had been buried on a bed of cinders, broken fragments of charcoal, and remains of all sorts, evidently the hearth on which the family cooked their victuals. The boy wore a necklace formed of two rows of the vertebræ of a fish and one row of small shells. At different points hung pendants cut out of the canine teeth of stags, decorated with parallel striæ. The man had also a necklace of fourteen canines of the stag, also striated. With the skeletons were found stone instruments, some of them finely worked, but none of them polished, and some bone implements of very rude fabrication. The man was very tall. If we judge by the length of his thigh-bone, his height must have exceeded six feet six inches. The teeth even of the boy were very much worn; those of the man were worn to the roots. The bones of many mammals have been found, but none belonging to extinct species, or even to the reindeer. On the other hand, no polished stone implement has been discovered. The remains, therefore, must be ascribed to the end of the quaternary or the beginning of the neolithic times. One cave is still unexcavated. The Prince of Monaco, whose property it is, has given orders that the excavations are to begin next spring.

Mr. C. Hedley read before the Linnæan Society of New South Wales, on August 31, a paper in which he presented an interesting study of ancient geography. The immediate subject was the range of *Placostylus.* He remarked on the essential unity of the *Placostylus* area as a zoological province, embracing the archipelagoes of Solomon, Fiji, Hebrides, Loyalty, New Caledonia, Norfolk Island (?), Lord Howe, and New Zealand; a unity explicable only on the theory that they form portions of a shattered continent, and are connected by shallow banks formerly dry land. Deep sea soundings, especially those of the *Challenger* in the Coral Sea, further demonstrate the existence of such a submarine plateau, for which the name of "The Melanesian Plateau" is proposed. Further, Mr. Hedley contended that the Melanesian Plateau was never connected with, nor was ever populated from, Australia; that its fauna and flora were originally derived from New Guinea.

In the *Proceedings* of the U.S. National Museum (vol. xv.), Lieut. Dix Bolles calls attention to an interesting object included in a collection of ethnological specimens given by him to the museum in 1883-85. This is a wooden mask, which has for its eyes two large bronze Chinese coins. The grave from which the mask was taken is near the Chilcat village, at the mouth of the Chilcat River, Alaska, where stands a row of six grave-houses on a narrow strip of land close to the river, with a swamp behind them. From this particular grave very little was obtained by the explorers, its contents having nearly all rotted away. Lieut. Bolles was told by the natives that it was the grave of a medicine man who had flourished more than 200 years before, six successors having filled his office, each one living to a good old age. Careful questioning failed to evoke any other answer. When the coins were shown to the Chilcats, they could not remember having ever seen such objects. Lieut. Bolles concludes that the coins probably were derived from a junk driven on the coast about two centuries ago. "To those," he says, "who doubt the advent of junks on the west coast at this early date, these facts will probably not be satisfactory, but it will be necessary for them to break down by direct evidence such a strong plea."

Messrs. H. Alabaster, Gatehouse & Co. have now in the press, shortly to be issued, a new work, entitled, "Domestic Electric Lighting, treated from the Consumer's Standpoint." The author is Mr. Ed. C. de Segundo.

"The Electrician" Printing and Publishing Co., Limited, have in preparation for their "Electrician" Series the following volumes:—"Electromagnetic Theory," by Oliver Heaviside; "Electrical Engineering Formulæ, &c.", by W. Geipel and H. Kilgour; "Submarine Cable Laying and Repairing," by H. D. Wilkinson; "Drum Armature Winding and Commutators: in Theory and Practice," by F. M. Weymouth; and "Electricity as a Motive Power," by Albion T. Snell, M.I.C.E., M.E.

The first series of lectures given by the Sunday Lecture Society begins on Sunday afternoon, October 23, in St. George's Hall, Langham Place, at 4 p.m., when Dr. Andrew Wilson will lecture on "The Distribution of Animals and what it teaches." Lectures will subsequently be given by Mr. Willmott Dixon; Prince Kropotkin; Mr. R. Brundenell Carter; Mr. Arthur W. Clayden; Prof. H. Marshall Ward, F.R.S.; and Dr. E. E. Klein, F.R.S.

Another memoir upon persulphuric acid and the persulphates is contributed by M. Berthelot to the *Annales de Chimie et de Physique*. As described in our note of vol. xliv., p. 577, the potassium, ammonium, and barium salts of this interesting acid were obtained last year by Dr. Marshall, of Edinburgh, in tolerably large quantity and in well-developed crystals. M. Berthelot, to whom the honour of the first preparation of persulphuric acid and its anhydride is due, now publishes his further work upon the subject, fully confirming Dr. Marshall's results, and adding a few more facts to our knowledge of the acid and its salts. The form of electrolysis apparatus which has been found by M. Berthelot to yield the best results consists of a double cell, the inner vessel of which is constructed of porous porcelain. The liquid contents of both the interior and exterior vessels are cooled by means of glass worms through which a constant current of cold water is maintained. The inner cell of 150 c.c. capacity contains a concentrated solution of potassium or ammonium sulphate, according as potassium or ammonium persulphate is required, in sulphuric acid diluted with six or seven times its volume of water. The nearer the composition of this liquid approaches to that of a solution of bisulphate of potassium or ammonium, the greater is the yield of persulphate. The exterior cell is simply filled with dilute sulphuric acid. The positive pole in the interior cell is most advantageously formed by a stout platinum wire, about one millimetre in diameter, as persulphuric acid is found by M. Berthelot to be rapidly decomposed in contact with a large surface of platinum. Platinum sponge, indeed, instantly decomposes the acid or solutions of its salts. The negative pole in the outer cell may conveniently take the form of a large plate of platinum. The current employed was one of three amperes derived from accumulators. At the expiration of fifteen to twenty hours the internal cell is found to contain large quantities of beautiful crystals of the persulphate. The usual yield of the potassium salt was 20-25 grams, and of the more soluble ammonium salt as much as 40-45 grams, in one operation. M. Berthelot has also obtained potassium persulphate by the direct electrolysis of sulphuric acid and subsequent addition to the product of a concentrated solution of potassium bisulphate, crystals of potassium persulphate, KSO_4, being at once deposited. This mode of preparation is not so advantageous as the method of production by the electrolysis of potassium sulphate as above, but affords interesting proof of the formation of free persulphuric acid by the electrolysis of oil of vitriol. M. Berthelot has further succeeded in preparing persulphuric acid by the gradual addition of anhydrous barium peroxide to concentrated sulphuric acid in a small flask surrounded by ice. So rapid is the action that if the addition of the peroxide is continued until the sulphuric acid is almost exhausted, even although the vessel is maintained in pounded ice, dense vapours are evolved which possess the remarkable odour and other properties of persulphuric anhydride. Another interesting fact observed by M. Berthelot is that a solution of potassium persulphate attacks mercury, even at the ordinary temperature, with production of a yellow basic sulphate which appears to be identical with the salt known since the times of the alchemists as *turpith mineral*.

The additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Miss E. A. Hill; two Racoons (*Procyon lotor*) from North America, presented by Captain Sharp; a grey Ichneumon (*Herpestes griseus*) from India, presented by Mrs. Wyndham Bewes; a Stanleyan Chevrotain (*Tragulus stanleyanus*) from Java, presented by Mr. Chas. J. Noble; a Vulpine Phalanger (*Phalangista vulpina*, ♂) from Australia, presented by Master H. H. Barret; a White Stork (*Ciconia alba*), European, presented by Sir H. Rae-Reid, Bart., F.Z.S.; an Ostrich (*Struthio camelus*, ♂) from Africa, presented by H.M. the Queen; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mrs. Davidson; three Negro Tamarins (*Midas ursulus*) from Guiana; a Canarian Laurel Pigeon (*Columba laurivora*, ♂) from the island of Gomera, Canary Islands; two Nicobar Pigeons (*Colænas nicobarica*) from the Indian Archipelago, deposited; an Indian Muntjac (*Cervulus muntjac*, ♀) from India; four Ringed Plovers (*Ægialitis hiaticula*) and two Dunlins (*Tringa alpina*), British, purchased.

OUR ASTRONOMICAL COLUMN.

Luminous Night Clouds.—In an article communicated to *Astronomische Nachrichten*, No. 3120, Herren W. Foerster and O. Jesse invite astronomers and geophysicists both here and abroad to make observations of the very interesting phenomena of luminous night clouds, the appearance of which has, up till now, been observed more or less only at Berlin. Since the year 1885, the authors tell us, these appearances have been most noticeable, and it is because they are now becoming less so that they wish to have as many observations made as possible. The phenomenon appears in the form of cirrus clouds, which stand out bright against the twilight sky. The colour generally noticed is that of a bluish white, and when the horizon is approached, gold and red tints are added. The best time for observation is said to be just before and after sunrise and sunset. From photographs taken at Berlin, it has been computed that these clouds are at a height of 82 kilometres. Long after the sun has set they are seen to reflect the sunlight, but as soon as they fall within the reach of the earth's shadow they immediately become invisible. The observations show, so far as may be judged from those already at hand, that the movements of this phenomenon after midnight are directed from the north-east ± 40°, and the authors think it highly probable that the resistance of the medium surrounding the earth accounts for these movements. This is to a certain extent affirmed by observations made at Punta Arenas and other places, the phenomena occurring six months after the conclusion of the Berlin observations. The authors suggest that eye observations (taken every few minutes) should be made in different latitudes, to ascertain the apparent height to which these clouds attain. The determinations of azimuth and altitude should also be current to three or four minutes of arc, and the time to two or four minutes. Notice should also be taken of the general state of the atmosphere at the time of observation, while photography should be employed to record their place and motion. The paper contains one or two more suggestions, among which is the employment of the spectroscope, and concludes with the hope that the importance of this phenomenon in relation to cosmical problems will arouse much interest and enlist many observers, for, in such a case as this, the observations of one institution will not help to solve such a general question as this.

NOVA AURIGÆ.—From the communications, in *Astronomische Nachrichten*, No. 3120, we make the following notes with reference to the magnitude and spectroscopic appearance of the Nova Aurigæ.

Dr. J. Holetschek, of the Vienna Observatory, has examined the star with regard to the former, and finds that, if any, an increase in brightness has taken place since August 24. The following are his figures, N. standing for the Nova, and *a* a neighbouring star, the magnitude of which is taken as 9·7. The hours refer to Vienna mean time:—

1892.	h.	N.	m.
August 24	13¾	0·5*a*	9·65
,, 26	14	2*a*	9·5
,, 27	14	1·5*a*	9·55
,, 28	12¾	2·5*a*	9·45
,, 30	12¼	2*a*	9·5
Sept. 2	14	3*a*	9·4

Observations made on Sept. 15 12h., Sept. 16 11½h., and Sept. 17 12½h. showed that N. was at least four degrees brighter than *a*, and two degrees brighter than the star, 9·5m. B.D. + 30°·924.

Using the 30-inch of the Pulkova Observatory, Mr. A. Belopolsky has made some measurements of the brightest line visible in the spectrum. His measures are:—

1892.	W.L.	Mean.
September 10	501·2μμ	
,, 12	501·1	
,, 14	(499·5)	501·0
,, 15	500·9	
,, 16	500·7	

Of the other lines there were seen D or D_3, F, and a dark line about wave-length 465μμ.

MINOR PLANETS.—The application of photography to the search of minor planets seems to be rewarded with remarkable success, for no less than four new ones, 1892, E, F, G, and H, have, since September 25, been discovered. The first two are due to M. Perrotin, while the last two were photographed by M. Wolf. A fact worth recording is that the plate, on which the latter planets were found, contained also two other images, those of the planets (34) Circe, and (184) Dejopeja; thus the positions of four planets were obtained with one exposure.

REPORT OF MR. TEBBUTT'S OBSERVATORY.—In this small pamphlet we have a condensed account of the present state of the observatory buildings, instrumental equipment, &c., together with the work done during the year 1891. Although the staff is not very great, yet the work carried out shows that all the available time has been made the most of. The observations include forty-six occultations of stars by the moon, phenomena of Jupiter's satellites, transit of Mercury, conjunction of Venus and Jupiter, and filar micrometer comparisons of the minor planet Ceres, comprising 106 comparisons and four comparison stars. Several comets were observed with the square bar-micrometer, while some interesting double stars and the two variables of Argus and R. Carinæ have also been worked at. The 9h. a.m. meteorological observations have been continued with the usual regularity.

PHOTOGRAPHIC CHART OF THE HEAVENS.—In a paper read on July 1, 1891, before the Royal Society of New South Wales, Mr. H. C. Russell relates many of his experiences, together with some of the results obtained during the preparation of the Sydney Observatory for the photographic chart of the heavens. The first difficulty that turned up had reference to the photographing of the stars of the fourteenth magnitude. The two minutes' exposure was found quite long enough for ninth magnitude stars, but the thirty minutes was not sufficient to record those of the fourteenth. A question also arose as to coloured stars, for in many cases stars visible telescopically were not photographed at all. Of the many objects photographed with the portrait camera, Mr. Russell describes very fully the beautiful nebula 30 Doradus. This nebula, as he says, is a great spiral structure, of which we see the greatest diameter, its thickness measured through in the line of sight being comparatively small. He has been able also to obtain a very fine photograph of N. Argus, a nebula, which, as may be concluded from the negative, "covers a much larger area than that of Orion." The same photograph also confirms the observations made by Mr. Russell in 1872 that a conspicuous part of the nebula which Herschel drew and described in 1838 has wholly disappeared, and that its place is now occupied by a dark round spot. What this may be is a doubtful question, but as Mr. Russell says "It cannot be a solid body, because the stars are there, but a slight misty body would hide the nebula and not affect the stars very much." The pamphlet concludes with an excellent picture of the κ Crucis cluster.

GEOGRAPHICAL NOTES.

COLONEL BAILEY, R.E., lecturer on Forestry in the University of Edinburgh, has been appointed secretary to the Royal Scottish Geographical Society, in room of Mr. A. Silva White, whose resignation on account of ill-health we noticed some months ago.

PROF. CHERSKI, whose projected journey in Eastern Siberia was mentioned in Geographical Notes for June 30 (p. 212) is reported to have died near Sredne Kolymsk, on his way down the Kolyma river towards Nizhne Kolymsk, where he intended to have passed the winter. Cherski has travelled frequently and far in Siberia, and has done much to elucidate the geographical conditions, and in particular the geology of many parts of Northern Asia. His great geological map of the Lake Baikal district is the work by which he will be best remembered.

THE current number of the *Scottish Geographical Magazine* contains Mrs. Bishop's account of her travels in Ladak and the adjacent territories, often called Lesser Tibet. As a record of personal adventure and observation of native character the paper ranks worthily with the published records of this traveller's earlier and later journeys.

THE *Proceedings* of the Royal Geographical Society for October publishes a short statement of the progress of Indian surveys during the last field season. In Bengal the Behar detachment completed the traverse survey of 1610 square miles in districts Muzaffarpur and Champaran. In Bombay 2536 square miles of detailed survey were completed on the scale of two inches to one mile, and 2100 square miles were triangulated in the Gujarat and Mahratta country. Two parties were at work in Burma. In district Sagaing 1842 square miles of cadastral survey and 1142 of traverse survey were completed, while 700 square miles of traverse survey were made in district Shwebo, and a topographical survey, on the scale of one mile to an inch, of 106 square miles of the Chindwin coalfields. There were also carried out in districts Amherst, Tavoy, and Mergin 881 square miles of cadastral survey, besides a traverse survey of 510 square miles.

THE MICRO-ORGANISMS OF THE SOIL.[1]

THE high office with which you have honoured me entails the delivery of an address, which I keenly feel I cannot give in keeping with the standard set by my distinguished predecessors.

Fermentation, though observed since pre-historic times, is perhaps less understood than any chemistry has to deal with. The exciters of fermentation are rendered exceedingly difficult of investigation, because they, like all living things, are subject to physiological—or more specially pathological—functions of life; they are so sensitive that any abnormal influence either changes their whole mode of existence or destroys it altogether; a medium suitable to the life of one special kind is changed by it into a product which ceases to sustain it, but can nourish a lower class of organisms whereby concomitant fermentations arise, whose united effects are frequently such as to completely modify those produced by each separately; and for this reason have the specific actions of some ferments either totally escaped observation or have been misconstrued. Every succeeding year brings additional proof of the important rôle played by these minute organisms, and to such an extent, especially, has this been the case in connection with the rendition of available nitrogen, that there are good reasons to believe that a clearer comprehension of the action of soil ferments will dissipate all the anxiety chemists now entertain as to a gradual diminution of this so essential nutrient.

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[1] Address delivered by Prof. Alfred Springer as Vice-President of Section C. at the meeting of the American Association for the Advancement of Science.

To Hellriegel, Wilfarth, Wollny, Engelmann, Winograwdski, Warrington, and Heräus can be attributed the most noteworthy experiments in this special line. In order to appreciate the importance of their discoveries, I will, with your kind indulgence, first give a brief historical *résumé* of the study of fermentation. Owing to the extreme age of the use of alcoholic beverages, ferments entering into their production are best known, and this, added to the fact of their being larger and thus permitting of better examination, has been the determining cause of basing investigations and deductions upon their behaviour.

The very fact that the art of cultivating the vine and making wine is attributed by the Egyptians to Osiris, the Greeks to Bacchus, the Israelites to Noah—the brewing of beer to Gambrinus—shows how old these discoveries must have been. The effects of fermentation are sufficiently striking to have called the attention of primitive man to them. The ancient tribes of Asia and Africa understood how to ferment not only grape juice, but also to obtain alcoholic beverages from substances like starch, not directly fermentable. They used soured dough or beer-yeast as leaven for their bread, and knew how to prepare vinegar. The alchemists were wont to clothe their thoughts in such words as to make it difficult for us to decide what precise ideas they attached to the expressions of "Fermentation and Ferments" which are so frequently found in their writings of the thirteenth to the fifteenth century. They even speak of the philosopher's stone as fermenting unlimited quantities of lead and mercury into gold.

In the fifteenth century Basil Valentine in his "Triumphal Car of Antimony" claims that yeast employed in the preparation of beer communicates to the liquor an internal inflammation, thereby causing a purification and separation of the clear parts from those which are troubled; but considers alcohol as already existing in the decoction of germinated barley. In 1648 Van Helmont declared fermentation the cause of all chemical action and spontaneous generation, going so far as to give directions for the production of mice, frogs, eels, &c. He clearly observed the production of a special gas (gas vinorum) during alcoholic fermentation, and stated that something from the ferment passes into the fermentable substance, developing therein like a seed in the soil, thereby producing fermentation.

Willis, an English physician, in 1659 claimed that all functions of life depended upon fermentation, and that diseases were but abnormal fermentations. Both he and Stahl regarded a ferment as a body endowed with a motion peculiar to itself, which it imparts to the fermentable matter. Stahl in 1697 advanced the following theory: "Under the influence of the internal motion excited by the ferment, the heterogeneous particles are separated from each other, recombining so as to form more stable compounds, including the same principles but in different proportions. Putrefaction is but a particular case of fermentation." This theory remained unchallenged eighty years.

Lavoisier, by applying the new methods of organic analysis he had invented, quantitatively ascertained the relations between the fermented matter and the products.

Guy Lussac considered oxygen the sole cause of fermentation, putrefaction, and decay, by transmitting its motion to the ferment and this imparted its motion to the loosely combined fermentable mass.

The present theories of fermentation originated with Schwann and Pasteur. It took a century and a half before the experiments which led up to Schwann's theory found a scientific explanation by the work of this chemist. Leuwenhoeck had in 1680 already noticed that beer yeast was composed of small spheroid globules. Cagniard de Latour declared yeast a plant and the exciter of fermentation.

Schwann's experiments were made to determine the possibility of spontaneous generation. He found that fermentable fluids, when first heated in closed vessels in the presence of oxygen, to the temperature of boiling water would not ferment. This disproved Guy Lussac's theory that oxygen caused fermentation. He next showed that purified air or oxygen passed into a sterilized fermentable fluid did not induce fermentation; but that this set in with the introduction of ordinary air. He concluded from these experiments that the air was not the exciter, but simply the medium containing it, and that in the floating particles of the atmosphere were organisms capable of developing in the fluid; should these be killed by heat, fermentation would not take place. In his examination of these organisms, although his methods were not absolute, his conclusions that alcoholic ferments are of a vegetable nature were correct.

Instead of general acceptance, Schwann's theory received but little recognition.

Schultze's method of first passing the air entering a sterilized fermentable fluid through oil of vitriol, and that of Schroeder and Dusch of filtering it through cotton can be regarded as modifications of Schwann's experiments. All these experiments conclusively show that the particles in the atmosphere are the exciters of fermentation but do not render them visible.

Pasteur, spurred on by the same motive as Schwann—namely, to determine the question of spontaneous generation—made a simple modification of Schroeder and Dusch's experiment, by substituting gun-cotton, and achieved most remarkable results. The gun-cotton, containing the particles filtered from the air, was dissolved in ether under the microscope, and now for the first time the organisms could be thoroughly examined.

Tyndall's well-known experiments, with the air-tight box coated with glycerine, demonstrated that gravity alone can purify the atmosphere so as to debar fermentation from setting in.

Pasteur's theory is that "The chemical act of fermentation is essentially a correlative phenomenon of a vital act beginning and ending with it; there is never an alcoholic fermentation without there being at the same time organization, development, multiplication of globules, or the continued consecutive life of globules already formed.

The following few examples will serve to show that the slightest changes in nutrients may render them worthless as such to certain ferments and available to others. Organic substances showing optical rotation chiefly exist already formed in the animal or vegetable organisms, or they can be easily obtained from such substances formed during vital processes.

When these substances are made synthetically, they are chemically and physically similar to the natural isomers, but usually do not rotate the plane of polarized light. This leads to the belief that these synthetical products consist of active and inactive molecules in such proportions as to neutralize each other.

Pasteur[1] verified his hypothesis by splitting inactive racemic acid into dextro-tartaric acid. Neutral ammonium racemate in a solution to which the proper inorganic salts had been added was fermented by means of *Penicillium glaucum* and beer yeast. The dextro-tartaric acid was consumed and the lævo left.

Lewkowitch[2] took inactive mandelate of ammonia, employing either *Penicillium glaucum* or *Bacterium termo*; in each case at the end of several weeks all the fluids showed more or less dextro rotation. Natural mandelic acid from amygdalin is lævo rotary, therefore here, as in Pasteur's experiment, with racemic acid it showed that the organisms consumed the naturally produced isomer.

Sac. ellipsoideus and split fungi consume the dextro and leave the lævo. The dextro has the same positive as the lævo negative rotation. The melting points and solubility of the right and left are the same, yet we see that these substances, chemically and physically the same, save in their opposite rotatory powers, can serve in one case as nutrients to certain organisms, and the other are worthless as such.

The Micro-Organisms of the Soil (*Sacchse*[3]).

These organisms, according to their actions, can be divided into three groups. Those oxidizing constituents of the soil those reducing or destroying the same; and lastly those by whose activity the soil is enriched. As regards the first group the oxidation can take place in two ways—they can either oxidize by assimilating the organic substances of the soil and reducing them to carbonic acid and water, in order to obtain the necessary heat and energy; or they can oxidize by giving off oxygen. The first may be termed intra-cellular, and the second extra-cellular acting organisms. Amongst the intra-cellular we have primarily, the usual ferments of decay, which assimilate and respire at the expense of the carbon compounds. In some cases the organisms have accommodated themselves to seemingly most remarkable materials for respiration, the combustion of which affords the necessary heat. Thus the Iron Bacteria of Winograwdski[1] require ferrous carbonate for their life and development, oxidizing the same to oxide. This can be physiologically interpreted as a respiration process, the protoxide of the respiration material becoming the oxide of respiration product.

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[1] Cr. xlvi. 615; li. 298.

[2] B. xvi. 1505, 1569.

[3] *Chem. Cent. Bl.*, 1889, vol. ii. 169, 225.

The Sulphur Bacteria are equally remarkable. Their cells are distinguishable by containing from time to time granules of amorphous sulphur. These organisms were formerly regarded as causing the formation of sulphuretted hydrogen in sulphur springs.

Winograwdski[2] claims the reverse to be the case. They do not produce sulphuretted hydrogen but consume it, burning it partially first to sulphur, which deposits in the cell water, then completely to sulphuric acid, which passes out and forms sulphates from the carbonates of the surrounding water. When no more carbonates are present, the combustion of sulphur to sulphuric acid ceases. Physiologically this is also a process of respiration directed towards generating heat and energy; sulphuretted hydrogen is the respiration material and sulphuric acid the respiration product.

(Olivier[3] does not agree with Winograwdski and De Rey Pailhade[4] claims the existence of a substance, philothion, in many plants and animal tissues capable of converting sulphur in the cold to sulphuretted hydrogen.)

Certain nitrification ferments can be regarded as intra-cellular. They may take up ammonia and give it off as nitrates, this process ceasing as in the case of the Sulphur Bacteria, when no more carbonates are present.

We now come to the discussion of two ferments, the concomitant actions of which have heretofore caused much confusion. Schloesing and Muntz were the first to observe nitrifying ferments, but to Warrington and Winograwdski belongs the credit of isolating the nitrous from the nitric ferment; furthermore, the striking discovery of a colourless organism, capable of existing and performing its functions, in a medium totally devoid of organic material, and synthetically producing organic bodies independent of sunlight. The importance of this discovery cannot be over-estimated.

Warrington[5] succeeded in obtaining organisms from meadow soil, cultivated in a solution of ammonium chloride and calcium carbonate, which oxidized ammonia to nitrous acid, but had no effect on nitrates. Assimilating the carbon of the carbon-dioxide, they require no organic substance for sustenance. They obtain from the oxidation heat of ammonia the necessary energy to dissociate the carbon-dioxide.

Winograwdski[6] obtained the same ferment employing 1 gr. ammonium sulphate, 1 grm. potassium phosphate dissolved in 1 litre Zurich water, to which he added basic magnesium carbonate. After inoculating the sterilized fluid with the nitrifying agent every trace of ammonia disappeared the fifteenth day. He describes this ferment as being an elongated ellipsoid, the smaller diameter 0·9 – 1 Mkr., the larger 1·1 – 1·8 Mkr. The organisms congregate about a piece of carbonate, cover it with their gelatinous mass, and as the carbonate disappears the cells take the shape thereof.

(Although the two investigators do not quite agree as to the morphological attributes of the ferment, Warrington arrived at the same conclusions as Winograwdski.)

Winograwdski[7] has at last succeeded in isolating the ferment which converts the nitrites into nitrates. He employed gelatinous hydrate of silica, impregnated it with a fluid containing the cultivated nitrous ferment. This medium was next inoculated with strongly nitrifying soil from Quito; shortly afterwards two different organisms formed respective colonies, one of these was the one sought for. It was composed of irregularly shaped rods, dissimilar to the nitrous ferment of the same soil. He has since found this ferment in many other soils; it is capable of converting solutions of nitrites into nitrates.

Strange to say the isolated ferment from Quito does not oxidize ammonia; it produced neither nitrites nor nitrates when sowed in ammoniacal fluids, easily nitrified by the nitrous ferment.

In normal soils the nitrate ferment only produces nitrates even in the presence of a large quantity of ammonia, which does not retard the oxidation of the nitrites immediately after their formation.

Muntz[1] claims the existence of an ammoniacal ferment in the soil which converts organic nitrogen into ammonia, preparatory to nitrification.

Extra-Cellular Oxidation.

In order to oxidize outside of the organisms, oxygen must be evolved by an assimilation process. Assimilation as an oxidizing cause, for conditions prevailing in the soil, has heretofore received no significance, since the evolution of oxygen, according to the generally accepted theories, depended upon light and chlorophyll, consequently the produced oxidation could only occur on the extreme outer surface. An exception to this heretofore unrestricted rule has been found by Engelmann as well as one by Heräus. According to Engelmann,[2] Bacterium photometricum sharply discriminates between lights of different intensity and wave lengths. The influence of light upon the bacteria is directly proportionate to the intensity. When the intensity is suddenly decreased, the bacteria shoot backwards with opposite rotation (the author calling this a terror motion), consequently a well-defined illuminated spot in an otherwise dark drop serves as a trap for these bacteria. They cannot leave, since the terror motion causes them to move back into the illuminated field as soon as they come to the dark outline.

The mobile forms principally congregate in the ultra red rays, *i.e.* physiologically in darkness, and in them as in the visible parts of the spectrum in places closely corresponding to the absorption bands of bacteriopurpurin. This constant ratio between absorption and photokinetic action clearly indicates that the prime effect of light is equivalent to the carbon-dioxide dissociating processes of plants containing chlorophyll.

The bacteriopurpurin is a true chromophyll, inasmuch as it converts the actually absorbed energy of light into potential chemical energy. When lights of different colour were employed, the evolution of oxygen increased with the absorption of light by the Purple bacteria. This shows that the power of developing oxygen is not the specific property of a certain colouring matter, as these organisms contain no chlorophyll.

It is not surprising, therefore, that other organisms, either coloured or uncoloured, be found to possess the property of assimilating carbon in the absence of light and evolving oxygen. Such a discovery has now been made—Hueppe[3] substantiating a communication from Heräus that certain colourless bacteria produce from humus and carbonates, in the absence of light, a body closely resembling cellulose. Oxygen is liberated, but remains unobserved, as it is immediately used to oxidize the ammonia to nitric acid.

The next question is: To which extent do the oxidizing organisms partake in the oxidation phenomena actually taking place in the soil? According to E. Wollny[4] the oxidation of carbon-dioxide is almost completely to be attributed to the activity of small organisms, of which Adametz[5] estimated that there are about 500,000 to 1 gr. soil. As in all such experiments, this conclusion is based upon the fact that no evolution of carbon-dioxide takes place, or is forced to a minimum, in a sterilized soil under otherwise favourable conditions.

Liberation of Combined Nitrogen.

This may take place during putrefaction under the greatest possible exclusion of oxygen, or during decay in the presence of oxygen. It does not necessarily occur in all cases, or may not be observed owing to a reverse concomitant process, *i.e.*, the fixation of nitrogen. Nitrogen losses can be expected during decay, on account of the action of the produced nitrous acid upon the amidlike dissociation of humous bodies, as well as in the formation of easily dissociable ammonium nitrites. A peculiar case of the disappearance of available nitrogen exists in the reduction of nitrates, as noticed by Springer,[6] Gayon and Dupetit,[7] and Deherain and Marquenne.[8]

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[1] *Bot Ztg.*, xlvi. 261.

[2] *Bot. Ztg.*, xlv. 489, 513, 545, 569, 585.

[3] Cr. cvi. 1744.

[4] Cr. cvi. 1683; cvii. 43.

[5] *Chem. News*, lxiii. 296.

[6] A. J. P., September 1890.

[7] A. J. P., v. 577; Cr. cxiii. 89.

[1] Cr. cx. 1206.

[2] *Bot. Ztg.*, xlvi. 661, 677, 693, 709.

[3] Ntf. Vers., lx.

[4] LV. St., xxxvi. 197.

[5] Inaug. Diss., Leipsic, 1886.

[6] *Amer. Chem. Jour.*, iv. 452–53.

[7] Cr. xcv. 644.

[8] Bot., vii. 138.

Organisms by whose Activity the Soil is Enriched in Nitrogen.

A distinction must be drawn between the higher and lower plants. It is a well-known fact that most plants cannot assimilate free nitrogen; whereas there are sound reasons for the belief that the legumes are exceptions to this rule. The explanation has been sought in the tubercles. These tubercles contain a tissue, consisting of thin-walled cells filled with an albuminous substance, consequently they are richer in nitrogen than the roots; they have been regarded by some as pathogenic growths, by others as reserve reservoirs for albumin. We may now conscientiously assume that these tubercles arise through exterior infection, and that they are not normal growths.

Hellriegel and Wilfarth,[1] in their great work, state:—"The legumes deport themselves quite differently from the non-leguminous plants respecting the assimilation of nitrogen, whereas the latter are totally dependent for their nitrogen needs upon the nitrogen compounds present in the soil, and their development proportional to such disposable supply. The legumes have, besides, the soil nitrogen, a second source, from which they can abundantly cover any deficiency existing in the first. This second source is free atmospheric nitrogen. The legumes attain this power by the co-operation of active living micro-organisms. The mere presence of low organisms in the soil does not suffice to make the free nitrogen serviceable, but it is necessary that certain kinds of organisms enter into a symbiotic relationship with the legumes.

Lupines acquire nitrogen like the other legumes. They starve in a soil free from nitrogen when the presence of low organisms is excluded; but when this is not the case their growth is normal. The experiments were carried on in sand containing a suitable nutritive solution. Some of the pots were sterilized; to some infusions from soil were added. In all and in only those, to which fresh infusions of lupine soil had been added the lupines developed normally bearing the well-known tubercles on their roots, and contained, when harvested, conspicuously larger amounts of nitrogen than the soil and infusion could have given them. Wherever the infusion had not been added, or where it had been sterilized at 100 or even 70, the development remained abnormal, the production scant; tubercles remained absent and the harvested plants contained less nitrogen than had been offered them.

According to Ward,[2] Breal,[3] and Pradmowski,[4] tubercles will grow on plants free from them when infected with an infusion from tubercles of other plants.

Beyrenick[5] has named the infecting organisms, of which there may be many varieties, Bacterium Radicola. With the growth of the tubercles the behaviour of the plant towards nitrogen is changed, and the just mentioned independence begins; this has been proved by an almost superabundance of experiments. Still the explanation of the manner in which the nitrogen is acquired is not definitely settled. The first inference would be that the root-inhabiting bacteria possess the power of assimilating atmospheric nitrogen, and the higher plants as hosts harbouring these bacteria in their roots, use the nitrogen compounds so produced. Thus there would exist a case of symbiosis between Split Fungi and the higher plants. We cannot be too slow in accepting this seemingly simple explanation—still the difficulty of a correct interpretation does not alter the fact that the legumes acquire free nitrogen from the atmosphere, and that the refuse of their roots thus enrich the soil. They may be called nitrogen collectors in contradistinction to the graminaceous nitrogen consumers.

Berthelot[6] has long contended that the free soil can fixate nitrogen; he considers a sandy and clayey nature of the soil essential, it must admit of free access of air, must not be too moist, be rich in potash and poor in nitrogen. Gautier and Drouin[7] claim that the presence of humous substances causes increase of nitrogen.

Soils free from organic substances do not fixate nitrogen, or the gain is slight. The presence of ferric oxide so long considered capable of fixing nitrogen, has no effect. Berthelot, as well as most investigators in this line, attribute the fixation to the activity of nitrogen fixing chlorophyll free bacteria. In most cases the amount is much less than that obtained in soils with legumes. No inorganic soil constituents are known to possess the power of fixing nitrogen, and it is questionable whether humous substances can directly do this.

In 1881 Atwater claimed that peas during their growth obtained large quantities of nitrogen from the air. Atwater[1] and Woods made another series of eighty-nine experiments; the result will be found in their admirable paper in the American journal. I will quote the following: "There was in no case any large gain without root tubercles; but with them there was uniformly more or less gain of nitrogen from the air. As a rule, the greater the abundance of root tubercles, the larger and more vigorous were the plants, and the greater was the amount of atmospheric nitrogen acquired. The connection between the root tubercles and the acquisition of nitrogen, which was first pointed out by Hellriegel, is abundantly confirmed. In a number of these experiments, there was a loss of nitrogen instead of a gain. The loss occurred where there were no root tubercles; it was especially large with oat and corn plants, and largest where they had the most nitrogen at their disposal in the form of nitrates. This loss may probably be due to the decomposition of the seeds and nitrates through the agency of micro-organisms. In brief, the acquisition of large quantities of atmospheric nitrogen by leguminous plants, which was first demonstrated by experiments here, and has been since confirmed by others is still further confirmed by the experiments herewith reported. These experiments in like manner confirm the observation of the connection between root tubercles and the acquisition of nitrogen. There is scarcely room for doubt that the free nitrogen of the air is thus acquired by plants."

Chemists, as a rule, hesitate to accept isolated cell life as modifying and conditioning the action of those more differentiated; yet it seems that all circumstances point to the fact that most reactions taking place between nitrogen and plants are influenced by micro-organisms.

Let us hope that chemistry will, in the near future, score its greatest agricultural triumph, by unveiling the mysteries which still shroud the specific actions of these organisms, thus making it possible to supply the demands of a constantly increasing population.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—A course of instruction (Lectures and Laboratory work) in sciences bearing upon Agriculture will be commenced in Cambridge this term; it will extend over two years and will include the following subjects:—Agriculture; Chemistry, elementary and agricultural; Botany, elementary and agricultural; some departments of Physiology and Geology; Agricultural Engineering, Surveying, and Mensuration. Arrangements will also be made for instruction in Book-keeping, and in Agricultural Law for those who desire it. The subjects taken this term will be Elementary Chemistry, by Prof. Liveing; and Elementary Botany, by Mr. Seward, of St. John's College. It is hoped that this course will prove useful to gentlemen intending to farm, or to manage their own land, and to those who are likely to become estate agents. Further information may be obtained from Mr. H. Robinson, at the University Chemical Laboratory, Cambridge Prof. Foster announces a new intermediate course in Physiology, with laboratory work, especially for medical students, to be given by Dr. L. E. Shore, on Wednesdays and Fridays at ten, during the Michaelmas and Lent terms.

Dr. Donald Macalister, St John's, has been appointed Assessor to the Regius Professor of Physic.

Mr. S. F. Dufton has been elected to a Fellowship at Trinity College, and Mr. A. Hutchinson of Christ's has been elected to a Fellowship at Pembroke College, in each case for distinction in Chemistry. Both gentlemen took first classes in each part of the Natural Sciences Tripos.

Mr. J. Y. Buchanan, F.R.S., University Lecturer in Geography will deliver a course of lectures on Oceanography during the present Term in the New Museums, on Tuesdays at 12 o'clock, commencing on Tuesday, October 18.

Mr. W. C. D. Whetham, B.A., Fellow of Trinity College, has been appointed Assistant Demonstrator of Physics in the Cavendish Laboratory.

Mr. W. B. Hardy, M A., Junior Demonstrator of Physiology, has been elected to a Drosier Fellowship in Gonville and Caius College.

[1] Z. Rub., xxv. I. 234.
[2] *Bied. Cent., Bl.*, xvi. 787.
[3] Cr. cvii. 397.
[4] N. Rd., iv. 201.
[5] *Bot. Ztg.*, xlvi. 725, 741, 757, 781, 797.
[6] Cr. cvii. 207, 852; cvi. 638, 1049, 1214.
[7] Cvi. 754, 944, 1098, 1174.

Amer. Chem. Jour., xli. 526; viii. 42.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, October 3. M. de Lacaze-Duthiers in the chair.—Observations of the new planet Borrelly, made at the observatory of Algiers (equatorial coudé), by MM. Rambaud and Sy, communicated by M. Tisserand.—On considerations of homogeneity in physics, and on a relation between the velocity of propagation of a current and the capacity and coefficient of self-induction of the line, by M. C. Clavenad.—On the coexistence of dielectric power and electric conductivity. A claim of priority advanced by Mr. E. Cohn over M. Bouty (see *Wiedemann's Annalen*, vol. xxviii. p. 454).—Comparative evaporation of the solutions of sodium chloride, potassium chloride, and of pure water, by M. Pierre Lesage. Within the limits of the experiments, pure water evaporates more rapidly than solutions of either chloride. The solutions of KCl have, with the same degree of concentration, a greater rate of evaporation than those of NaCl.—On a fossil piece of wood containing fluorine, by M. T. L. Phipson. This was found in the cretaceous sandstone of the Isle of Wight, and analysed thirty years ago. It yielded 32·45 per cent. of phosphoric acid and 3·90 per cent. of fluorine. It had a brown colour and a density of 2·71.—Identity of cascarine and rhamnoxanthine, by the same.—On a respiratory globuline contained in the blood of the chitons, by M. A. B. Griffiths. The yellow blood of the chitons contains a respiratory globuline which contains no metal. It is colourless, and possesses the same properties of oxygenation and deoxygenation as hæmoglobine, chlorocruorine, and other respiratory substances. Its empirical formula is

$$C_{621} H_{814} N_{175} SO_{169}$$

It has been named β-achroglobine, to distinguish it from that of the Patella, which has been called acroglobine.—Influence of the electric light on the structure of herbaceous plants, by M. Gaston Bonnier. After his researches on trees carried out at the electric station of the Paris Central Markets, the writer experimented upon herbaceous plants under similar conditions. The plants were placed at distances varying from 1·5 to 4m. from arc lamps, whose light was kept constant for seven months. The excess of ultraviolet radiation was intercepted by glass shades. Under these circumstances, the majority of plants exhibited intense activity of assimilation. 12 gr. of leaves of *Ranunculus bolbosus* developed 1·05 of oxygen in one hour, the corresponding figure for diffused daylight being 0·52, and for full sunlight in midsummer 3·95. A certain proportion of plants died off, even in intermittent light, especially if no shade was used. Some plants showed an exuberant vegetation, the leaves a deeper green, and the petals more striking colours. Of these, however, the larger number soon began to suffer from excessive assimilation. Some were able to adapt themselves completely, such as bulb plants, grasses raised from seeds, arborescent species, and submerged aquatic plants. The latter also showed no difference in structure, whereas the leaves of crocuses, anemones, and ranunculi became almost unrecognisable owing to anatomical modifications. As a general result, if the continuous electric light through glass produces a great development in an herbaceous plant accompanied by an intense green, the structure of the organs is at first highly differentiated; but if the electric light is intense, and prolonged for several months without change, the new organs formed by the plant, which are able to adapt themselves to this kind of illumination, present remarkable modifications of structure in their various tissues, and are less differentiated, although always rich in chlorophyll. Further, the direct electric light is prejudicial to the normal development of the tissues in virtue of its ultra-violet rays, even at a distance of more than 3m.

Göttingen.

Royal Scientific Society, March to June.—The following scientific papers have appeared in the *Nachrichten* :—

March.—Bürger : Preliminary contributions to a systematic account of the Nemertean fauna of the Gulf of Naples.

April.—Wallach and Marmé : New chemical combinations of vegetable origin.—Hecht : Contributions to geometrical crystallography.—Hurwitz : On the theory of Abelian functions, generalising algebraic functions into multiplier-functions and stating the generalised "Roch" theorem.—Schönflies : Certain rectilinear portions of Riemann surfaces.—Fricke : Discontinuous groups whose substitution-coefficients are integral numbers belonging to a quartic "Körper."—Fricke : Modular correspondences.—Fricke : On the *s*-function (2, 3, 7).—Ritter : One-valued automorphic forms of deficiency zero.—Lindemann : Solution of equations by transcendental functions. (Second note. See Roy. Soc. of Göttingen, 1884.)

June.—Hallwachs : Velocity of light in dilute solutions.—Klein : *Real* relations in Abelian functions.—Bodländer : Molecular combinations in solutions.—Traube : The crystal forms of optically uniaxial substances.—Drude : The theories of light tested by practical physics.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Matriculation Chemistry : Temple Orme (Lawrence and Bullen).—Elements of Human Physiology : Dr. E H. Starling (Churchill).—A Vertebrate Fauna of Argyll and the Inner Hebrides : J. A. Harvie-Brown and T. E. Buckley (Edinburgh, Douglas).—Le Léman Monographie Limologique ; F. A. Forel : Tome Premier (Lausanne, Rouge).—Epidemic Influenza : Dr. F. A. Dixey (Clarendon Press).—Das Photographische Pigment-Verfahren : Dr. H. W. Vogel (Berlin, Oppenheim).

Pamphlets.—Étude sur la Courants et sur la Température des Eaux de la Mer dans l'Océan Atlantique : General H. Mathiesen (Christiania, Larpent).—Jupiter and his System : E. M. Clerke (Stanford).

Serials.—Engineering Magazine, October (N. Y.).—Contributions from the U.S. National Herbarium, vol. i. No. 5 (Washington).—Himmel und Erde, October (Berlin, Paetel).—Veröffentlichungen aus dem Königlichen Museum für Völkerkunde, 2 Band, 3/4 Heft (Berlin, Spemann).

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THURSDAY, OCTOBER 20, 1892.

FRESNEL'S THEORY OF DOUBLE REFRACTION.

The Optical Indicatrix and the Transmission of Light in Crystals. By L. Fletcher. (Oxford University Press Warehouse, 1892.)

MR. FLETCHER has given us a valuable and most interesting book. He has attacked some parts of the theory of double refraction in a manner which is free from many of the objections that may be made to the method more usually adopted, and which has the advantage of closely resembling that by which Fresnel himself made his great discovery.

In dealing with this discovery we must carefully bear in mind two facts. The result of Fresnel's theory—the determination of the actual form of the wave-surface in a biaxal crystal—is undoubtedly true; the mechanical reasoning on which, in his second memoir on double refraction, he bases that result, is as undoubtedly false. In recent times the explanation of the properties of the wave-surface has been usually based on the erroneous mechanical reasoning. Mr. Fletcher, following Fresnel himself, has shown us how all these properties may be deduced from certain experimental results without the introduction of the false mechanics. In one sense this is a backward step, but since the advance had been in the wrong direction, it was necessary to retreat, and though Mr. Fletcher's book teaches us nothing new of the mechanism of double refraction, it puts the kinematics of the theory and the geometrical results which it entails on a suré foundation, and this is an achievement for which the author deserves our warmest thanks.

The history of the discovery of the law of double refraction, as given in Fresnel's own papers, is of the deepest interest. The form of the wave-surface, in a uniaxal crystal, a sphere and spheroid, had been discovered by Huyghens. Up to the time at which Fresnel wrote it was generally supposed that even in a biaxal crystal one ray obeyed the ordinary law of refraction. In 1816 Fresnel and Arago proved that in an isotropic medium the direction of the periodic disturbance to which light is due is transverse to the ray, and from that time Fresnel set himself to investigate the laws of double refraction. He soon saw that the reasoning which led him to expect that in a uniaxal crystal the velocity of one wave must be constant could not apply to crystals with two optic axes, and that in such, contrary to the usual belief, there could be no ordinary ray. This was announced in June 1820. The first memoir on double refraction, presented to the Academy November 19, 1821, but not printed till 1868, gives a detailed account of the experiments by which this result of his theory was verified, and contains the earliest development of the theory itself. According to Fresnel's views at this time the ether displacement in a crystal was at right angles to the ray—it is noteworthy that the latest development of the mechanical theory leads to this same result—and the velocity of propagation depended on the elasticity of the medium in the direction of displacement. Since, then, for any ray there are two possible velocities there must for that ray be two and only two directions of displacement, the light must be polarized in one of two directions. Since, also, the velocities are different in different directions, in Fresnel's view the elasticity corresponding to a given direction of vibration must depend on the direction, and a surface of elasticity can be drawn each radius of which shall be proportional to the elasticity in its own direction. When once this surface is known, the rest of the problem can be readily solved. Now, in the memoir we are referring to ("Premier Mémoire sur la Double Réfraction, Œuvres Complètes d'Augustin Fresnel," T. ii. No. xxxviii.) Fresnel proved, for the case in which the double refraction was not strong, for which therefore the distinction between the ray and the wave normal might be neglected, that if for a uniaxal crystal the surface of elasticity were a spheroid of revolution the wave surface and the laws of double refraction would be those discovered by Huyghens. It was an easy step from this to generalize and to suppose that in a biaxal crystal the surface of elasticity might be an ellipsoid, and to examine the results. This gave him at once, to the same degree of approximation as in the previous case, the form of the wave surface known by his name and the experimental laws of biaxial refraction discovered by Brewster and by Biot. As yet the result was only approximate; worked out more completely the theory can be shown to lead to the same form of the wave surface as that developed by Lord Rayleigh (*Phil. Mag.*, June, 1871). Huyghens' laws and those of Biot and Brewster are not accurately obeyed.

But Fresnel's mind moved rapidly, and a week later, November 26, 1821 ("Extrait d'un Mémoire sur la Double Réfraction," Œuvres, Vol. ii., No. xxxix.), he corrected his first results and announced his complete theory. The modifications required were not great; in his original theory he had supposed the displacement to be at right angles to the ray, in the final form it is supposed to be at right angles to the wave normal, *i.e.*, in the wave front, while the elasticity in any given direction, and therefore the corresponding velocity, is given by the reciprocal of the radius vector of a certain ellipsoid instead of by the radius vector itself. With these modifications the wave surface is accurately Fresnel's surface and the experimental laws of double refraction are accurately obeyed. To this ellipsoid (of which the inverse is Fresnel's surface of elasticity) Mr. Fletcher has given the name of the "Indicatrix." According to Fresnel's theory the two possible velocities of wave propagation in any direction are the reciprocals of the axes of the section of the indicatrix by the wave front. This law has been verified to a high degree of accuracy by direct measurement, and is thus made by Mr. Fletcher the basis of his treatment of the problem. These Memoirs of Fresnel's remained unpublished till 1868. The only printed announcement of the results was a notice in the *Moniteur*, December 12, 1821, with a view of claiming priority for the discovery, and the Report of the Referees, Fourier, Ampère, and Arago, who (August 19, 1822) recommended that it should be printed in full in the "Recueil des Savants Etrangers."

Instead, however, the Second Memoir on Double Refraction (Œuvres, tome ii., No. xlvii.) was printed (tome vii. of the Recueil) in 1827, the year of his death, and this is the paper which contains Fresnel's latest developments of his theory. In it he suppresses entirely his method of generalization and develops that mechanical theory by which, to quote his biographer Verdet, "he endeavoured to rediscover truths which a profound intuition had first revealed to him." The truths remain, and though Fresnel's methods and their historical development are clearly given in his collected works and in M. Verdet's most admirable introduction to them, Mr. Fletcher has done good service to science in calling fresh attention to these earlier papers and in making a modification of this method of Fresnel's the foundation of his work.

In his note to the first memoir, when discussing the inexact reasoning by which Fresnel afterwards supported his mechanical theory, Verdet writes ("Œuvres de Fresnel," ii., p. 327):—

> "Il pouvait sembler singulier que le résultat définitif d'un raisonnement incomplet et inexact en deux points fût une des lois de la nature dont l'expérience a le mieux confirmé la vérité. On a vu au contraire que cette loi s'était manifestée à Fresnel comme le résultat d'une généralisation toute semblable aux généralisations qui ont amené la plupart des grandes découvertes. Lors qu'il a voulu ensuite se rendre compte de la loi par une théorie mécanique il n'est pas étonnant qu'il ait, peutêtre à son insu, conduit cette théorie vers le but qu'il connaissait d'avance et qu'il ait été déterminé dans le choix des hypothèses auxiliaires moins par leur vraisemblance intrinsèque que par leur accord avec ce qu'il était en droit de considérer comme la vérité."

True though this may be, the fact remains that until Lord Kelvin developed his theory of a contractile ether a few years ago, no one of the distinguished men who have followed in Fresnel's steps had discovered a satisfactory mechanical basis for Fresnel's great generalization. But to return to the book before us. As has been mentioned, Mr. Fletcher's method of development differs somewhat from that indicated by Fresnel. He finds it more convenient to work with rays than with wave-normals or wave-fronts, and the construction he adopts is the following:—Draw a normal at any point of the ellipsoid of elasticity—the indicatrix in Mr. Fletcher's language. From the centre of the ellipsoid draw a line perpendicular to this normal, and consider a ray travelling in the direction of this perpendicular. Then the reciprocal of the intercept on the normal between the surface and the ray measures the velocity of propagation along the ray, and the plane of polarization of the ray touches the indicatrix at the point at which the normal is drawn. According to Fresnel's theory the radius vector drawn from the centre to this point is the direction of vibration in the ray, while according to the most recent modification of the theory, the motion takes place along the normal itself. From this simple construction the form of the wave-surface and all the known laws of the propagation of light in crystals are deduced in a strict and skilful manner. At the same time, while giving Mr. Fletcher the fullest credit for his originality, we are at times inclined to wish he had adhered more closely to Fresnel's method. He admits of course himself that a single ray cannot be propagated through the ether. We may hope that some of those who read his book will go on to study the mechanical theory of double refraction. Then they must deal with waves and not with rays, and they would find it an advantage to have had the one idea to guide them throughout. Again, the new method leads to a multiplicity of names for one and the same thing, and this is a disadvantage. We have ray-surface used for wave-surface, although the two are identical, nor is it easy at first to recognize the optic bi-normals and the optic bi-radials as the optic axes and the lines of single ray velocity respectively; but these are small points when compared with the main object of the book, which well deserves attention and careful study. The last chapter deals with the problem in a more general way, but space forbids us to follow Mr. Fletcher into the questions he there raises; it must suffice to call the reader's attention to it, and especially to the fallacy discussed in Section 17.

R. T. G.

THE PROGRESS OF HORTICULTURE.

Contributions to Horticultural Literature. By William Paul, F.L.S. (Waltham Cross, Herts: W. Paul and Son, 1892.)

For about half a century Mr. Paul has been labouring at the work of horticulture alike in the garden and at the desk. As a business man he has not confined himself simply to commercial routine. As an observer and an experimenter he has not been hedged in by the dogmas and prejudices of any particular school of science, and as a writer his aim has always been to record truthfully and instruct faithfully. It is a matter of congratulation, therefore, that the author should have gathered together in a convenient form some records of a lifetime's work.

Certain portions we should have eliminated as of past or of personal interest only; certain others as of relatively minor importance; but Mr. Paul is addressing a mixed audience with varied sympathies and interests, and it may be that the paragraphs we should mark for deletion would be those which others would best care to preserve.

Mr. Paul groups his writings, as here collected, under the three heads of (1) roses, (2) trees and plants, and (3) fruit culture and miscellanea. They would fall equally well under other categories, such as the commercial and practical, the æsthetic and the biological. In this notice we must confine ourselves to Mr. Paul's writings as a naturalist. Such, however, is the interdependence among various branches of inquiry, that it is almost impossible, in this connection to isolate any special subject, even if it were desirable to do so. From this point of view Mr. Paul's book is, though undesignedly, an apt representation of the present condition of horticulture. On the one hand, the relations of that art to the perception of and to the canons of beauty are obvious. Equally clear are its bearings on routine practice. On the other hand, its connection with biological science, in spite of the teaching and example of Darwin, is not yet adequately recognized; nor has the statesman as yet grasped the truth that progress in agriculture must follow to a large extent on the lines familiar to horticulturists. Of the many remedies proposed to mitigate and clear away the depression under which agriculture is suffering, none is more likely to be serviceable than the adoption, so far as circumstances permit, of the principles and practice of the progressive gardener. This is very obvious to those conversant with the state of commercial horticulture, as contrasted with the condition of the corresponding department of agriculture, and it will be brought home to the thoughtful reader by the perusal of some of Mr. Paul's pages. It is interesting, too, to see that matters at which some minds would still be inclined to scoff as unpractical, or which they would regard as mere means of affording agreeable recreation, are the very departments in which the greatest practical successes have been achieved in the past, and which are of the best augury for progress in the future.

Biologically speaking, Mr. Paul has been not only a keen observer but a careful experimenter on a very large scale, and over a very long period. It is true his experiments have not been and could not have been made with the exact accuracy which we expect in the laboratory, but they have been made under conditions far more akin to those which occur in nature. Moreover, they have been made, although with a definite aim, yet without reference to any particular theory. The reader will accordingly find in these pages records of work and inferences from carefully planned experiments directly bearing on many subjects now attracting the attention of naturalists, such as hereditary transmission, variation from seed or from bud, selection, fixation, close fertilization, and the various degrees of cross-impregnation. Incidentally these subjects receive illustration in many chapters of Mr. Paul's book; but the address on "The Improvement of Plants," which was read in 1869 before the provincial meeting of the Royal Horticultural Society at Manchester, contains a summary of Mr. Paul's views on these subjects, which we strongly commend alike to the notice of naturalists and of agriculturists.

It is very interesting to compare what he says about selection and variation in plants, such as the Camellia, the Chinese Primrose, or the Hollyhock, which are the offspring of what we regard as pure species, with the corresponding processes in the Rose, the Pelargonium, or the Chrysanthemum, which are veritable mongrels. In this connection we may in passing allude to the power which the gardener has, of course within limitations, of creating new forms. The orchid cultivator, for example, inferred parentage of certain hybrids met with in a wild state, but he has since proved the correctness of his inference by actually producing in his orchid-house many of the same forms that occur in the forests of the tropics. Another very striking case (not specially alluded to by Mr. Paul) is the production and development of what are known as tuberous Begonias. These have been evolved by the art and patience of the gardener within the last quarter of a century from repeated crossing between certain Andean species of Begonia and their descendants. The result is the establishment of a race so totally distinct from anything yet known in nature as would justify a systematic botanist in forming a separate genus for their reception. Many an accepted genus is based upon less important points of distinction than those which characterize the tuberous Begonias, and which, indeed, have been gathered together by Fournier under the genus Lemoinea. The degree of permanence of this artificially formed genus is, of course, unknown; but we do know already that the peculiarities are reproduced from seed, and that each year the plants are, as the gardeners say, becoming more "fixed." We have alluded to these as illustrations of the kind of work upon which Mr. Paul has been engaged for half a century. They may be taken as examples of the material he has gathered together in this book, which is not merely presented for the delectation of the ordinary lover of flowers or the profit of trading horticulturists, but is also calculated to increase the productive resources of the country, as well as to forward the progressive development of our knowledge of the natural history of plants.

As a further illustration of Mr. Paul's method we cite in conclusion a passage which will, we think, justify us for recommending to scientific readers the perusal of a book which they might be disposed, from its title, to think had little in it to interest them. "My experience in selecting, hybridizing, and cross-breeding tells me that he who is seeking to improve any class of plants should watch narrowly and seize with alacrity any deviation from the fixed character, and the wider the deviation the greater are the chances of an important issue. However unpromising in appearance at the outset, he knows not what issues may lie concealed in a variation, sport, hybrid, or cross-bred, or what the ground newly broken is capable of yielding under careful and assiduous cultivation. If we would succeed in this field we must observe, and think, and work. Observation and experiment are the only true sources of knowledge in nature, and while observing and experimenting we should above all things guard against prejudices."

MAXWELL T. MASTERS.

LIFE IN MOTION.

Life in Motion; or, Muscle and Nerve. By John Gray McKendrick, M.D., F.R.S. (Adam and Charles Black, 1892.)

UNDER this title Prof. McKendrick gives us the gist of six lectures delivered by him during last Christmas holidays to a juvenile audience at the Royal Institution of Great Britain; and, judging from this little work, it is evident that no pains was spared by him to render these lectures as instructive and interesting as abundant illustrations and experiments could make them. In presenting these lectures to the public in book form he places us under an obligation gratefully to be acknowledged, for professional physiologists stand alone amongst their colleagues in other departments of science in their disdain of any attempt at the production of attractive and simple scientific literature. In very pleasing sympathetic style the reader is introduced to the world of motion and to the special motions of the living muscle. He is shown how the movements of a muscle are recorded by the physiologist, and the apparatus used for its stimulation. Artificial tetanus is described, the muscle sound and its elasticity referred to, and a perhaps too short description given of amœboid and ciliary motion. The physiology of the nerve is then discussed, and the production of heat in muscle. In the fifth lecture is a short account of the sources of muscular energy, a comparison is drawn between a muscle and the steam-engine, and a comparatively detailed account of muscle fatigue is given.

The sixth and final lecture deals with the electrical phenomena of muscle and with a very curious group of fishes termed "electrical."

The arrangement of the book is excellent, yet we are inclined to think that it shares with many other works on physiology one common fault. What we all want to know more about is the life and activity of the organism, and the physiologist very rightly spends much of his time in experimenting in every conceivable way, and generally with isolated parts of the organism. His apparatus is often of the most varied and intricate kind, and his experiments yield him definite results. Many of these results, however, are at present of little value in shedding light on physiological processes, and should not, we think, obtain the prominent position they now occupy in the text-books. To take an example, the experiment to demonstrate the muscle curve, in which the muscle is isolated and stimulated electrically, is one of the stock experiments minutely described in every text-book. In this experiment the muscle is separated from its antagonistic muscles, stimulated in quite an unnatural way, and the result of the experiment is totally different from what takes place in a contracting limb. It is certain that in nearly every text-book the reader will find that from this and similar experiments he is apt to obtain incorrect and misleading ideas. He no doubt learns something regarding very interesting electrical machinery, but very little physiology. Of recent years far more attention has been bestowed upon the movements of muscles in the limbs, and comparative physiology is at last asserting its influence. It is to be hoped that when this knowledge finds a more prominent place in text-book literature, "muscle and nerve physiology," in the proper sense of the term, will be more satisfactorily taught.

Returning to what more exclusively concerns Prof. McKendrick's book, we may point out a slip on page 81, where it would appear that the muscle sound corresponds in pitch to the fundamental tone of a body vibrating 19·5 times a second, instead of to one vibrating at twice that rate, and that Prof. McKendrick does not interpret this sound on the lines followed by Helmholtz and others. On page 91 the modern view of a "cell" is represented in a drawing, and the nucleus has inadvertently been omitted. On page 31 a long and short circuiting key is represented, while a simple key is described in the accompanying text. These, however, are but trivial faults to find in an excellent little work, which is most admirably got up and beautifully illustrated by nearly one hundred excellent figures.

The reader will, we think, obtain a good insight into a department of physiology, and will be stimulated to further research in the literature of this interesting subject.

J. B. H.

PLUMBING.

Principles and Practice of Plumbing. By S. Stevens Hellyer. (London: George Bell and Sons, 1891.)

THOSE who are acquainted with Mr. Hellyer's larger book on domestic Sanitation, "Dulce Domum," will not find much new matter in the present volume, but the subjects are treated less discursively, and are fairly well brought down to date.

There is no trade which has been more discussed in recent years than that of plumbing, and if plumbers are not impressed with a sense of their responsibilities, it is certainly not the fault of the architects and engineers who employ them. The manual skill necessary to perform the most ordinary operations is in itself so difficult that many workmen fail to acquire it; and, on the other hand, many experts in the details of the craft are never properly educated in the principles of sanitation which are necessary to make their work effectual from a sanitary standpoint. It is the combination of both kinds of knowledge in the writer which makes Mr. Hellyer's books of exceptional value. It matters little whether it is an architect on one hand, or a working plumber on the other, who studies them, because they are of equal value and of equal interest to both. The present handbook is specially valuable in these respects because most of the information upon matters of practical workmanship is given concurrently with the reasons which should control the details and the principles which should be in evidence when the work is finished.

No one unacquainted with the practical difficulties which frequently crop up in sanitary practice can realise how much knowledge and experience is necessary to overcome them. Houses in London often present the most puzzling problems, and an intimate acquaintance not only with the principles and practice of the subject, but also with all the most recent appliances, is required for their successful solution. The ventilation of all the different parts of a complicated drainage system, including that which is necessary to prevent the syphonage of traps, sometimes requires an amount of thought and attention which a layman would think was uncalled for in the face of its apparent simplicity. It is no wonder that there are frequently failures to meet the highest standard of excellence, especially when incompetent persons are employed to design and superintend the necessary operations. On the other hand, there are thousands of houses in London in which no such difficulties occur, and in which the drainage and plumbing arrangements ought not only to be extremely simple in themselves, but intelligible to the ordinary householder. When such cases are entrusted to a builder, or an intelligent plumber, the first requisite is the manual skill required to carry out the various details, and this must be acquired by the workman through apprenticeship, or from his having acted as the assistant or "mate" of a journeyman for several years. The next requisite is that he should have a clear knowledge of what he is going to do and why he does it. This may be acquired to a great extent from his being familiar, in his capacity as a workman, with the designs of an architect or engineer under whose directions he has been employed, and it is to such men that Mr. Hellyer's text-book should be specially valuable. By studying its pages he will avoid many mistakes. He will know what sort of joint to make, what kind of trap to avoid, how to secure the traps from syphonage, and how generally to complete his work so as to pass the latest standards of excellence. We can equally recommend it as a text-book for architects who, although they are unable to acquire any technical skill in carrying out the operations themselves, should have, nevertheless, an intimate knowledge of the principles which they ought to embody.

We think that more space should have been devoted to that portion of the book which deals with drainage proper. While nearly 100 pages are given to lead-laying and the jointing and bending of pipes, only about twenty pages are devoted to house-drains, and a great part of this is occupied with illustrations of appliances. Not more than one or two pages are given to the subject of cast-iron drains, although they are strongly recommended, and the subject is a very important one. We trust, however, that the author will remedy these deficiencies in the future editions which will doubtless be required to supply the demand for his excellent text-book.

OUR BOOK SHELF.

A Lecture Course of Elementary Chemistry. By H. T. Lilley, M.A. (London: Simpkin, Marshall, Hamilton, Kent and Co., 1892.)

THE abrupt use of chemical terms, and the condensed style adopted by the author in this book, make it evident that it is not specially designed to smooth down the difficulties which confront the unaided learner who approaches chemistry for the first time. It seems rather to be fitted to replace the notes which might be taken on a course of lecture instruction. Regarded in this light it is a useful volume, the knowledge it contains being, in the main, sound and to the point.

It deals with the metals as well as with the non-metals, and dovetailed with the ordinary chemical information are many instances that the author has tried to keep pace with current work, and has attempted to give the student all the important points to be noted in a fairly complete course of elementary chemistry.

A short series of exercises chiefly in chemical arithmetic are given at the end of the book, and a table of contents and an index are supplied.

It would be advisable on p. 53 to say that ordinary sulphur crystallises in the rhombic system. To speak of the crystalline form as an octohedron tends to create an impression common among students, that ordinary sulphur belongs to the cubic system. Fluorine was not made by the electrolysis of liquefied hydrofluoric acid, but of a solution of potassium fluoride in the acid; the pure acid is a non-electrolyte.

It is hardly correct to state that calcium sulphate and hydroxide are the only known examples of solids less soluble in hot than in cold water; calcium isobutyrate and one of the thorium sulphates are additional instances. On p. 98 the flame colorations of potassium and sodium are confused, and brass seems to be omitted in treating of the alloys of copper and zinc. J. W. R.

Longmans' School Geography for North America. By George G. Chisholm and C. H. Leete. (New York: Longmans, Green, and Co.).

IF Mr. Chisholm's well-known geographical text-book was to be extensively used in the United States, it was inevitable that it should be altered in a way which would adapt it to the special needs of American schools. The task was undertaken by Mr. Leete, and he has accomplished it with much skill and judgment. The parts he has rewritten are those relating to America in general, North America, and the United States. To these he gives a prominence which was not necessary or desirable for European students of geography, but which is no doubt essential for learners on the other side of the Atlantic. The plan of Mr. Chisholm's book and the spirit of its execution have both been maintained, and the work ought now to be quite as useful in the New World as it has already been in the Old.

Garden Design and Architects' Gardens. By W. Robinson, F.L.S. (London: John Murray, 1892.)

THE author of this book is firmly convinced that to clip and align trees in order that they may "harmonise" with architecture is "barbarous, needless, and inartistic." He is in love with Nature's methods, and would give them in gardens much freer scope than is accorded to them by persons who like best a certain trimness and formality. It is to be regretted, perhaps, that Mr. Robinson deals with the subject in so polemical a temper, but the cause for which he contends is good, and he does excellent service by bringing out prominently what has always been the essential principle of the best and most characteristic kind of English landscape gardening. The value of the essay is greatly increased by a number of well-selected illustrations.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Alleged "Aggressive Mimicry" of *Volucellæ*.

IN the course of a review (NATURE, October 6, 1892, p. 535) of a book, "Animal Coloration," by Mr. Beddard, Mr. Poulton takes occasion to refer to a theory professing to elucidate the resemblance of *Volucellæ* to humble-bees, &c. This reference is occasioned by the suggestion of a counter-hypothesis by Mr. Beddard. The view adopted by Mr. Poulton ("Colours of Animals," 1890, p. 267) is that proposed by Kirby and Spence, and subsequently alluded to by Künckel d'Herculais ("Organ. et Dével. des Volucelles," Paris, 1875) and others; but as Mr. Poulton makes no reference to these authorities he may be assumed to accept the full responsibility. In the place named he says:—"The boldness of these enemies sometimes depends on the perfection of their disguise. Thus the larvæ of flies of the genus *Volucella* live upon the larvæ of bees and wasps. *Volucella bombylans* occurs in two varieties, which prey upon the humble-bees *Bombus muscorum* and *B. lapidarius*, and are respectively like these Hymenoptera. The resemblance is very perfect, and the flies enter the nests to lay their eggs." Mr. Beddard (*l. c.*, p. 225) criticizes the view that the fly resembles the bee that it may with impunity enter the nest, and proposes to look on the presence of the fly's larvæ in the bees' nests as akin to the presence of supposed "pets" in the nests of ants. As Poulton points out, this suggestion leaves the original difficulty of the likeness of the fly to the bee untouched.

Having little interest in either of these speculations, which seem fantastic and premature, it is with reluctance that I take part in the discussion. The case, however, of *V. bombylans* is not only interesting as a striking, and to us in England a most accessible instance of the phenomenon of Mimicry, but as an example of Variation it is almost unique among animals, while among plants perhaps it is paralleled only by Darwin's famous case of the peach and the nectarine. It is besides a case well suited for experiment and close observation. The nests of surface building bees may towards evening be lifted bodily, bees, *Volucellæ*, and all, with a spit of earth, and transferred to a box. This may be taken home and set next morning on a window-sill, when on opening the box the bees will go on with their work for the rest of the summer. If any one seeks an opportunity of honestly trying to get to the bottom of a case of Mimicry, instead of speculating about it at large, he can scarcely find a better case than this. The need for such observations is great, for the account confidently given by Poulton, though according well with his hypotheses, accords with the truth less well.

In these circumstances it may not be out of place to give a brief statement of the facts as they were established by entomologists long ago. The *Volucellæ* are a small group of flies, containing four British species (Verrall, "Cat. Brit. Dipt.," 1888); of these most if not all resemble various Hymenoptera. The commonest and most remarkable is *V. bombylans*, which may be seen in any English hedgerow on a sunny day in early summer. This fly exhibits the rare condition of existing in two distinct forms in both sexes. The one form is black with a red-tail, in no small degree resembling a small worker of a red-tailed humble-bee. such as *B. lapidarius* L. or *B. Derhamellus* Kirb. The other form has a yellow border to the thorax, yellow hairs on the antero-lateral parts of the abdomen, and a grey tail, to an equal degree resembling a small worker of one of the several yellow-banded humble-bees, *e.g. B. hortorum* L., *B. terrestris* L., or *B. Scrimshiranus* Kirb. Both varieties occur in both sexes and are about equally common. The problem of the evolution of these distinct forms is thus one of the most complex. Some may ask, If the varieties are thus distinct, how are they known to be one species? The evidence of this is (1) that no point of structure can be found to differentiate them, (2) that males of the one variety have been seen coupled with females of the other and *vice versa* (Macquart, "Suites à Buff.," p. 479; Zeller, *Stet. ent. Ztg.*, 1842, p. 66), and lastly (3) that intermediate forms have been found as rarities (Erichson, *Stet. ent. Ztg.*, 1842, p. 115). This evidence may not satisfy all, but as regards Mr. Poulton the identity of the two as one species is not in dispute, for he admits this.

But though the likeness of *V. bombylans* L. and its var. *mystacea* L. (= *plumata* de Geer) to the red-tailed humble-bees and to the yellow-banded humble-bees respectively, is really close, neither these forms nor the less common var. *hæmorrhoidalis* Zt. present any special likeness to *B. muscorum* L., which has a bright brown thorax and a grey abdomen. It is true that Künckel has spoken of a resemblance between the var. *mystacea* and *B. muscorum*, but it is hard to see upon what ground, for indeed it is much as if one were to liken a tabby cat to a fox. As Künckel himself says, the great resemblance of the fly is to the yellow-banded *B. hortorum*.

To return to Mr. Poulton's statement, he says that the two varieties prey upon "*Bombus muscorum* and *B. lapidarius*, and are respectively like these Hymenoptera." These words contain an ambiguity which I cannot believe intentional. But supposing for a moment that one of the varieties *were* like *B. muscorum* (which it is not), the sentence must be taken to mean that each variety preys upon the species of bee which it most resembles, the red-tailed variety on the red-tailed bee and the yellow variety on the other. This is indeed demanded by the hypothesis of "Aggressive Mimicry." In this form the statement is often made, though I never met it elsewhere in print. I invite Mr. Poulton to produce observations in support of that statement. If he will establish it he will do a useful work. When this statement was written I must believe that Mr. Poulton had not read the several authorities on the subject, many of whom relate how both varieties have been reared from the nests of each type of bee, both from the red-tailed and from the yellow-banded (Künckel, p. 58; Drewsen, *Stet. ent. Ztg.*, 1847, p. 211; F. Boie, Kröyer's "Naturh. Tids.," 1838, p. 237). It is still possible that both varieties are born of one mother, and it is possible, too, that each female does her best to choose the nest of a bee like herself, but in support of this hypothesis I know no evidence; and indeed Künckel (p. 58), after considering this possibility, gives it as his opinion that probably the varieties of *V. bombylans* lay indifferently in the nests of all *Bombi*. From the omission of these facts, which to an appreciation of the evidence are vital, we should infer that Mr. Poulton was not acquainted with Künckel's work, were it not that he repeats Künckel's selection of *B. muscorum* as a form resembled by one of the two varieties.

But though Mr. Poulton is wrong in saying that either variety specially resembles *B. muscorum*, he is right in saying that *V. bombylans* preys on this bee's nests, for *both* varieties have been bred from them, even from the same nest (Künckel, p. 58). In my rooms at this moment are several nests of *B. muscorum*, each containing many larvæ of *V. bombylans*, resting for the winter, to emerge in summer, as I hope.

There is then evidence that the two varieties, though they may breed together, yet remain substantially distinct; and that though they respectively resemble different species of bees, they are both found together, not only in nests of bees which they resemble, but also, and in my own experience, more abundantly, in the nests of another bee which they do not resemble.

Mr. Poulton further omits to mention that *V. pellucens*, though in nowise resembling the common wasp, yet lives in its nests, together with *V. inanis* which does resemble a wasp, and *V. zonaria* which is like a hornet (Künckel, pp. 54 and 55). This fact also I commend to Mr. Poulton's ingenuity.

The publication of statements like this of Mr. Poulton's, omitting most salient facts—facts, besides, which, though adverse to his speculations, add a ten-fold interest to the subject—is surely unfortunate. It may be replied that Mr. Poulton's book is of a popular character and does not aim at the completeness of scientific work; but in making choice of evidence, even for popular exposition, it is well to remember that the value of facts is not to be measured by the ease with which they may be momentarily fitted to the sustenance of a facile hypothesis. WILLIAM BATESON.

St. John's College, Cambridge, October 9.

Induction and Deduction.

MISS JONES agitates a question that ought not to settle down without having caused that discussion which its propounding is fit to awaken.

This discussion does not, however, relate to the mutual relations of Induction and Deduction—at least, not as the main topic thereof. It relates to the fragmentary condition of that which is usually referred to and accepted as logic. We are so apt to take it for granted that our so-called logic is tolerably competent and complete as an account of human reasoning in general, that it is of great utility when some one—as Miss Jones does now—raises a question that is adapted to direct our reflections towards some one of the several, perhaps many, gaps that exist in that most important, but too often not understood and misunderstood, branch of science. It is with this specially in view that I have ventured to write this.

In geometry nothing is more usual than to draw a universal conclusion from a case that, to all ordinary ways of apprehension, seems to be a single instance. Indeed, this is one of the cardinal features of geometrical reasoning. Perhaps we might well say that it is the most characteristic feature. It is this feature that the question that Miss Jones agitates ought to call into prominent notice.

She selects for her purpose the case of the isosceles triangle, and asks, How, from premising that the angles at the base of an (one) isosceles triangle are equal to each other, are we logically warranted in concluding that that same equality is true of all isosceles triangles?

That we do thus conclude is known to all, as is also the truth that such a conclusion is a typical one in geometry. Nor have we, nor can we have, the least misgiving as to the rigorous validity of such conclusions.

It would be a digression for me to point out here the essential characteristics of that form of reasoning which, properly speaking, is induction. It is sufficient for my present purpose to remark that true induction is utterly unable to yield us any conclusion that is more than *probable and approximate*.

From these characteristics alone we may know that our geometrical conclusions in view are *not*, as Miss Jones takes them to be, inductive conclusions.

But since our geometrical conclusions are natural and valid, the question still remains, What sort of conclusions are they?

If we propose to call them deductive conclusions, then, when we revert to the array of syllogisms, categorical, hypothetical, disjunctive, dilemmatic, &c., we find none of them, nor any combination of them, that can by any means be made applicable. We have to get not merely from an apparently particular but from an apparently absolutely singular proposition to a universal one. To do this deductively, the body of doctrines and canons, that is usually called logic, confesses itself wholly unable. It lays down as one of its cardinal rules, one that it declares is "founded upon the Laws of Thought," that if any premise is particular, then only a particular conclusion can be drawn.

Nevertheless, I am going to submit that the reasoning under discussion is a true instance, not of induction, but of deduction. I submit that the reasoning that we do actually follow is that which may be formulated thus:—

This isosceles triangle is ANY *isosceles triangle.*

The angles at the base of this isosceles triangle are equal to each other. Therefore, the angles at the base of any (or every or all) isosceles triangle are equal to each other.

In order to make the nature of this reasoning plainer, I will put the same in symbols.

Put X = the isosceles triangle in general;
Z = this particular isosceles triangle;
a = angles at the base;
e = equal to each other.

Then our reasoning will appear thus:—

Z is X,
a of Z is e;
∴ a of X is e.

This looks very much as though we had in hand a case of the logic of relatives.

We will all recollect the challenge of De Morgan:—"If any one will by ordinary syllogism prove that because every man is an animal, therefore every head of a man is a head of an animal, I shall be ready——to set him another question." This would be in symbols—

All M is A;
∴ h of M is h of A.

Our case, according to this sort of formulation, would appear—

Z is any X;
∴ a of Z is a of X,
a of Z is e;
∴ a of X is e.

The distinguishing characteristic of our case as compared with the case put by De Morgan resides in the different natures of the two propositions—

All M is A,
and Z is any X.

The former is the usual universal categorical affirmative proposition of ordinary logic. The latter is a sort of universal categorical affirmative proposition that certainly exists and is important, but which has not yet been recognized, unless it may be by the quantifiers of the predicate in their proposition—

All A is all B.

It implies rigorously that not only

Z is any X,
but that Z is every X,
Z is all X,
any (or every or all) X is Z
„ („ „) not X is not Z
„ („ „) „ Z „ X
any X is every Z
every X is any Z
every not X is any not Z
any „ „ „
&c., &c.

In truth, to a superficial notice, it may easily seem to confuse the most important logical distinctions. But this is only because we are so used to identifying logic in general with the logic of extension. It is the logic of extension, or in other words, metric logic, that has been persistently tendered to us as the only logic worthy of study, if not indeed as the only logic practicable or perhaps possible. Yet we can now, I think, see that geometry at least makes great use of a logic that is not the logic of extension, and that the existence of geometry is an earnest that that other logic may be developed and formulated, if not completely at least to some very useful extent.

The proposition,

Z is any X,

is, as I conceive, a proposition of the logic of intension. It applies not to things, or to concepts in connection with things, but to pure abstract concepts like geometrical figures, whose marks are exhaustively specified, or, if any are not specified, the same depend upon and are implied by those that are specified.

One point more remains to be explained.

We must not from the recognition that Z is any X, and the rigorously following proposition that whatever is true of either X or Z is true of the other, conclude that these propositions should if valid hold for marks that are accidental to Z, or to any single instance of X. If we fail to keep clearly in mind the intensive scope of our propositions, we may discredit them, or one of them, by observing that although we have laid down that whatever is true of Z is true of any X, yet nevertheless it does not follow that Z is any X, as regards say the size of Z or any single instance of X. Size may not be any necessary mark of either, and if so it is for all logical purposes impertinent to the propositions in question, and must be altogether ignored.

I will conclude by saying that the inference actually made in the case put by Miss Jones is a deduction, because it necessarily follows from the premises laid down. Logic has no connection with the truth of premises; it only says what certain propositions entail. If in an intensive sense this isosceles triangle is any isosceles triangle, then any isosceles triangle is this isosceles triangle, and every isosceles triangle is this isosceles triangle, and all isosceles triangles are this isosceles triangle, and if the angles at the base of this isosceles triangle are equal to each other, it follows necessarily that the angles at the base of all isosceles triangles are equal to each other.

Chicago, August 16. FRANCIS C. RUSSELL.

BY the courtesy of the Editor of NATURE I have been allowed to read Mr. Francis C. Russell's very interesting remarks with reference to my note on "Induction and Deduction" in NATURE of July 28 (p. 293).

I agree with Mr. Russell as to the validity and certainty of an inference from equality of angles in *one* isosceles triangle to equality of angles in *all* isosceles triangles. But while I regard this inference as a "true induction" because it is an inference to a general proposition on the strength of a particular instance, Mr. Russell denies that it is an induction because he holds that induction can give only approximate and probable conclusions, and considers that the certainty which he allows to belong to the geometrical conclusion in question is due to the fact that the inference is *not* from a particular instance, but is really and truly *from* universal *to* universal—the one isosceles triangle from which the argument starts being a kind of "pure abstract concept," so that we can say—

This one isosceles triangle is *any* isosceles triangle; therefore *every* isosceles triangle is *this* isosceles triangle, &c.

This appears to me to be entirely inadmissible. How can *this* triangle *BE that* and *the other* triangle? To say that it is, is to lose sight of the distinction between *identity of individuality*, and *similarity of characteristics*. And that the assertion (*this* triangle is *every* triangle) is untenable appears also from Mr. Russell's own admission further on, when he says that "we must not, from the recognition that Z is any X, and the rigorously following proposition, that *whatever* is true of X or Z is true of the other, conclude that these propositions should, if valid, hold for marks that are accidental to Z or to any single instance of X." If Z *is* any X, how can any X have marks which Z has not, or Z have marks which any X has not? We cannot get out of the difficulty by reference to extension and intension, for this reason, that every categorical proposition, to be significant, must be read both in "intension" and in "extension"—that is, affirmatives must be understood as asserting identity of extension (application) in diversity of intension (signification), while negatives *deny* identity. "This isosceles triangle is *any* isosceles triangle" can have a useful signification only if it is interpreted to mean—

This triangle [not *is* but] *is similar* (in so far as isosceles) *to* any isosceles triangle—that is, all are *similar* in respect of the characteristics which are inseparable from equality of sides. Hence (as I said in my letter, July 28) "in all cases equality of angles at the base is inseparable from equality of sides."

I am not clear what precise meaning can be attached to the expression "pure abstract concept," still less how a geometrical *figure* can be an abstract concept. I am, moreover, disappointed that Mr. Russell makes no examination whatever of my own attempt to formulate the process from Particular to General.

With reference to Mr. Russell's symbolical argument—

Z is X,
a of Z is e,
∴ a of X is e,

I think that it may be logically described as a process either (1) of Substitution (Jevons)—a kind of Immediate Inference dependent on identity of application—thus:—

Z is X;

∴ X may be substituted for Z.

In *a* of Z is *e*
substitute X for Z,
and we have *a* of X is *e*.

Or (2) a combination of what Jevons calls Immediate Inference by Complex Conception (which I should like to class with some other Immediate Inferences as Extraversion, which is largely used in mathematics) and Mediate Inference; thus—

Z is X . . . . (*a*)
.·. *a* of Z is *a* of X . . . . . . (*b*)
But *a* of Z is *e* . . . . (*c*)
.·. *a* of X is *e* . . . . (*d*)

(*b*) is Inference by Complex Conception from (*a*); (*b*) and (*c*) are the premisses which give (*d*) as their (syllogistic) conclusion.

Cambridge, October 11. E. E. Constance Jones.

The Temperature of the Human Body.

Mr. Cumming's second or "physical" query will, I think, require no answer if his first or "physiological" question is replied to. If an isolated muscle from which evaporation was prevented could go on working in a heat enclosure, and always remain at a lower temperature than the enclosure (which it could only do by transferring heat from itself to its surroundings), we should have to ask in good earnest how this was consistent with the Second Law of Thermodynamics. We are quite certain, however, that the temperature of the working muscle would always, when a steady state of things had been reached, be above that of the enclosure.

The temperature of an isolated muscle during activity (assuming that it could be kept alive and evaporation prevented) would, of course, not only be very much higher "at the equator" than "at the pole," but also somewhat above that of the surrounding bodies in either latitude. The intact homoiothermal animal, even when the temperature of the air is greater than that of its blood, is on the whole, within the limits which can be borne, always losing more heat to its surroundings than it receives from them. For heat is still becoming latent at the evaporating surfaces of the body, the skin and the respiratory mucous membrane, even when the balance of gain and loss by radiation, &c., is telling the other way; and, indeed, in general more evaporation than usual is going on when this is the case. The temperature of these surfaces is always kept below that of the blood which comes to them. The blood, therefore, always loses heat here, and gains it from the muscles, which accordingly transfer heat to a medium colder than themselves, even when the external temperature is higher than that of either.

If, of two similar and similarly situated men, A and B (I ask pardon for degrading an austere geometrical phrase to such loose and vulgar application), exposed to the same high temperature (above that of the blood, say), A sweats little and B much, while the blood-temperature of both remains constant, A must either produce less heat than B or lose more in other ways than evaporation of sweat. He may produce less either because he works less than B, or because even at rest his metabolism is not so active. Or an extra loss of water-vapour from the lungs may make up for the diminished loss from the skin. For example, in the dog, which has but few sweat-glands, nearly the whole of the evaporation takes place in the respiratory tract. Of course much water is evaporated from the skin which never appears as visible sweat; and it is possible that some persons give off a greater proportion of the total perspiration in this way than others do, the quiet steady sweater, if one may be allowed the expression, getting through as much work on the whole as the steaming paroxysmal kind of fellow who breaks out into dewdrops on the smallest provocation. But it should be clearly recognized that an air temperature equal to or above that of the blood is occasional, and not permanent in any latitude, and that men, and even animals, adopt expedients to avoid such extremes and to tide them over.

Any good recent text-book of physiology will give the information asked for as to what is known of the mechanism by which the temperature of warm-blooded animals is kept approximately constant. It is too wide a subject to be entered into here. In man the regulation of the heat loss seems to be far more important than any regulation of the production of heat. The former is, of course, largely voluntary, but the quantity of blood going through the skin, an important factor in more than one way, is greatly influenced by reflex nervous impulses. It is doubtful whether the very considerable heat capacity of the bodies of large animals has been sufficiently taken into account in its bearing on the steadiness of the blood temperature. This in itself prevents any *sudden* change. In some animals, and apparently more especially in small animals—*e.g.*, the rabbit and guinea-pig—the production of heat, as well as the loss, is very distinctly under the control of the nervous system, and is increased when the external temperature is lowered, and diminished when it is raised.

Of course, as your correspondent is doubtless aware, we do not really know what kind of a machine a muscle is, except that it is a machine by means of which the potential energy of the food is partly transformed into mechanical work and to a much greater extent into heat. Up to a certain limit the work and the heat *increase together*, although less heat is given off by an active muscle which is allowed on the whole to do external work than by the same muscle when it constantly undoes its own work.

G. N. Stewart.

New Museums, Cambridge, October 11.

The following brief account of the working of the heat mechanism of the human body will, I hope, help to make clear to Mr. Cumming the problems of which he seeks the explanation.

The temperature of a man at the equator is within a degree Centigrade the same as that in the arctic regions. This is because, in the first place, in the arctic regions the loss of heat from the body is very slight, and in the tropics it is very great, for (*a*) in the tropics more perspiration is secreted by the skin, and this, in consequence of the high temperature of the air, evaporates very quickly, and hence the body is kept cool. It is true, as Mr. Cumming says, that in the tropics people may not be observed to perspire freely, but that is simply because as fast as the perspiration is secreted it is evaporated. It is what is called insensible perspiration. (*b*) More water is secreted by the bronchial mucous membranes in the tropics, and in consequence of the higher temperature of the air it, like the perspiration, evaporates very quickly. The excessive secretion of moisture by the body when the temperature of the air is high, is shown in a Turkish bath, and leads, in a bath of about two hours' duration, to a loss of weight amounting with some persons to three pounds, and to a great diminution in the quantity of urine secreted. (*c*) In the tropics the vessels of the skin are more widely dilated than in the arctic regions, hence there is more blood in it, and therefore heat is more readily radiated and conducted from the skin to the external atmosphere. (*d*) The specific heat of the body is very high, and so it cools very slowly in the arctic regions. Judging from some experiments I have made on animals, it is, at the usual temperature of the human body, well over 1·0. (*e*) The above facts are certain, but in addition, for all we know to the contrary, the skin may, under different conditions, have different radiating powers quite apart from the quantity of blood in it.

In the second place, although it has not been calorimetrically proved, it is very highly probable that in the arctic regions the quantity of heat produced by the body is much greater than in the tropics.

With regard to the second query of Mr. Cumming, no doubt, as he says, the human body in the tropics must often be the coolest of surrounding objects; in this case it cannot lose anything by radiation or conduction, but it is kept cool by the rapid evaporation of perspiration (usually insensible) and fluid secreted by the bronchial mucous membrane. Whether or not a man in the tropics produces any heat under such circumstances has not been demonstrated, but probably, although the production of heat falls very low, it does not entirely cease.

65 Harley-street, W. W. Hale White.

Photographic Dry Plates.

I have found great difficulty in obtaining fresh photographic dry plates of whatever maker, from dealers, who frequently pass off upon the purchasers packets of plates which have been in stock for a long time, and consequently unfit for use. It has therefore occurred to me that this trouble might be avoided by the makers dating every packet as issued by them, thus following the custom of the Platinotype Company with their tins of paper. By such a system the purchaser would be able to protect himself, and many makers' plates would be found much more satisfactory.

I shall esteem it a favour if you will allow this letter to appear in your journal. Enclosing my card, I subscribe myself,

October 17. PREVENTION.

INVITATION TO OBSERVE THE LUMINOUS NIGHT CLOUDS.[1]

SINCE the year 1885 a very remarkable phenomenon has been noticed in the sky in our latitudes, which well deserves to excite the interest of astronomers and geophysicists. The following is the substance of what has so far become known regarding the so-called luminous night-clouds.

In the latitude of Berlin the phenomenon shows itself only during a comparatively short period of the year—from May 23 to August 11. While in the first years it was seen pretty frequently even before midnight, it has, during the last four years, rarely appeared except after midnight. The phenomenon appears in the form of cirrus-clouds, which come out bright on the twilight sky. This especially distinguishes them from the ordinary cirrus-clouds, which, with the depths of the sun in which the luminous clouds are seen at present, come out dark on the light twilight sky. The colour of the phenomenon is generally a bluish white, which becomes yellowish and reddish in close proximity to the horizon.

Often repeated photographs which have been taken simultaneously at various points in the neighbourhood of Berlin, show that the altitude of the luminous clouds is constant and exceedingly great—82 kilometres. In consequence of this great altitude, they receive light from the sun standing *below* the horizon, which makes them appear light on the twilight-sky. They are visible only so long as the sun shines on them; as soon as the shadow of the earth passes over them they become invisible. As a rule they begin in the morning, shortly before twilight, and they disappear as soon as the sun stands higher than 8° to 10° below the horizon.

Of late years these clouds have been seldom seen. Within the period above stated, they occurred this year only about ten times, while in the first years they were very frequent. Their appearance is subject to great changes; while they frequently exist only in a few little luminous stripes or patches, at times they appear in greater accumulations and with a more intense light. Especially in the last days of the period, from August 2 until 6, their light seems to be considerable in our latitudes. Generally they are observed in the proximity of the horizon—over that part of it under which the sun is.

Frequent observations of the movements of the phenomena, which, after midnight, are always from the direction of N.E. ± 40°, render it probable *that the movements are caused principally through the resisting medium of the mundane space.* In accordance with this is the fact that in the half-year after its appearance in this country, the phenomenon has been observed repeatedly in the southern latitudes of 53° by the meteorological observer, Mr. Stubenrauch, in Punta Arenas, as well as several times by ship-captains.

Other observations confirm the assumption of an annual wandering of this kind. For instance, in Graham's-town under 33° S. lat. the phenomenon was observed on October 27, 1890,[2] and in Haverford under 40° N. lat.; according to written information it was observed on May 17, 1892. These dates, taken in association with the time of the appearance in this country, directly indicate a wandering of the phenomenon from N. to S. and back.

The luminous night-clouds decrease year after year in respect to the frequency of their appearance as well as to their extent and to their intensity of light. The phenomenon therefore will entirely disappear within a few years. It seems, however, that during the next two years observations will still be possible, which may give us information regarding several questions of extraordinary importance.

Measurements of the apparent altitude of the upper limits of the luminous clouds, mainly in the time in which the upper limit of the twilight-segment has the comparatively small altitude of, say, 1° to 10°, would be of great value. Such measurements will serve to decide the question whether the altitude of the clouds varies under different geographical latitudes, providing that the measurements always refer to such points as lie within the upper limits of the clouds, produced by the shadow of the earth.

During the last few years the whole twilight-segment has been comparatively seldom filled out by the luminous night-clouds, and it may therefore frequently remain doubtful whether the highest point of the phenomenon really lies in the limit of the earth-shadow. In order to make sure that the measurements are adapted to their purpose, they must be repeated as often as possible in intervals of a few minutes. In the evening this limit is generally recognized by the fact that within it parts of the phenomenon disappear from above, while towards morning new parts always become visible within the limit upwards. The distance of the zenith of the upper limit of the luminous clouds in the vertical of the sun for the latitude of Berlin, presuming that the phenomenon stretches over the whole of the twilight-segment, may be seen from the following statement:—

Depth of the sun below the horizon. °	Zenith distance of the upper-most limit. °
12·0	80
12·5	83
13·0	85
13·5	86
14·0	87

Moreover, as by means of a telescope the upper limit of the phenomenon is generally seen a little higher than with the naked eye, it is desirable that the telescope should always be adjusted to the limit-line seen with the naked eye. A comparison of the appearance seen with the naked eye with the one seen through the telescope, will enable the observer to discover easily the line corresponding to the one seen with the naked eye. The exactitude of these measurements must be about 3′ to 6′, with respect to the azimuth and to the altitude, while the time should be exact within two to four seconds.

The employment of photographic apparatus is of advantage for the indication of the place, as well as of the movements, of the phenomenon. But only those kinds of apparatus are suitable in which the proportion of the diameter of the opening to the focal distance is at least 1 : 4 or greater. If the proportion is smaller, the duration of lighting will last too long, and consequently, on account of the quick changings of the phenomenon, the details will get lost. With an apparatus of which the proportion of the aperture-diameter to the focal distance is 1 : 3, the duration of lighting for the various depths of the sun below the horizon, on condition that the phenomenon is light in some degree, is as follows:—

Depth of the Sun below the Horizon. °	Duration of Lighting. s.
9	16
10	21
11	27
12	35
13	48
14	72
15	122

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[1] Scientific journals are requested to reproduce this article.

[2] Compare *Astr. Nachr.*, No. 3008.

Generally at the same time stars become visible on the photographic plate, through which, in association with the time of photographing, the direction of adjustment of the apparatus is ascertained (that is to say, the position of the axle of the apparatus is ascertained).

With regard to equatorial regions, it is of great importance that the exact time in which luminous night-clouds pass through them should be determined. According to the observations hitherto made, the passing through the equator may take place in the time between the beginning of September and the end of October, and the return between the beginning of March and the end of April. Under 20° S. lat., the time of passing through will, in that case, be from the middle of September until the middle of November, and from the middle of February until the middle of April, and under 20° N. lat. from about the middle of March until the middle of May, and from the middle of August until the middle of October. In consequence of the daily rotation of the earth round its axis together with the distinct movements of the earth, atmosphere, it may be that the passing through the equator does not take place in the simple manner here described. It does not seem to be unlikely that the periods are not limited as exactly as stated.

Moreover, it is probable that the luminous night-clouds consist of a gas which is condensed in consequence of the lower temperature prevailing in the altitude of 82 kilometres. On the question relating to the nature of this gas depend several other cosmical questions: for instance, with respect to the temperature of the air of the mundane space and the temperature of the atmosphere at the altitude of 82 kilometres, which will be answered through comparing experiments in the laboratory. For this reason, spectrographs of the sunlight at low altitudes of the sun, in the season in which the phenomenon of the luminous night-clouds is seen, are of great value. Such spectrographs should be taken in the evening shortly before sunset, and in the morning shortly after sunrise.

It appears that in the northern regions of the earth, in about 70° latitude, in the period from the middle of June until the middle of July, an especially great accumulation of clouds takes place, which, however, on account of the sun standing constantly *above* the horizon during this period, will be hardly visible. It will, therefore, be of special advantage for these regions to take spectrographs of the sunlight at low positions of the sun.

These short remarks regarding the importance of the phenomenon with reference to cosmical problems may serve to show that the observations necessary for the exploration of the subject are well within the sphere of astronomers and geophysicists. There can be no doubt that the observations necessary for the solving of these questions are far beyond the capacity of a single institution. Those who take interest in the furtherance of the questions we have indicated are therefore requested to assist through one or other of the kinds of observation above noted in the investigation of the luminous night-clouds.[1]

W. FOERSTER.
O. JESSE.

Berlin Royal Observatory, September 1892.

SOME OPTICAL ILLUSIONS.[2]

A STRIKING illusion, first described by Zöllner some thirty years ago, and usually called by his name, appears in Fig. 1. Of the four main lines each adjoining pair seems to converge at one end, and to diverge at the other, whereas in reality the lines are all parallel. The first step in an explanation of the illusion would be the determination of its essential factors, of its various forms, and of some general principle embracing under one formula its several varieties. The next step would be to correlate this formulation with some recognized psychological principle. The generalization is found in the statement, that *the direction of the sides of an angle are deviated toward the direction of the angle*, and may be illustrated by reference to Fig. 2. In this figure the continuation of the left horizontal line seems to fall below the right horizontal line, and the continuation of the latter above the former; in reality the two are continuous. Similarly, if the continuations of the oblique lines be added, they will not seem continuous, but divergent slightly to one side or the other. If now we call the direction of an angle the direction of the line that bisects it, then the deviation is what would result from a drawing up of the sides of the angle towards this central bisecting line; the left end of the left horizontal line would be drawn up, and the right end of the right horizontal line would be drawn down, and thus the two seem discontinuous. The same would happen, though to a less degree, if either oblique line were omitted. There are many other ways of illustrating this fact. Instead of drawing the right line horizontal, we may incline its right end downwards slightly, and then it will seem continuous with the left horizontal line. We may apparently incline both lines so that they would converge towards a point between and below them, as in Fig. 3 and the like. Two further points or corollaries should be noted: (1) that the

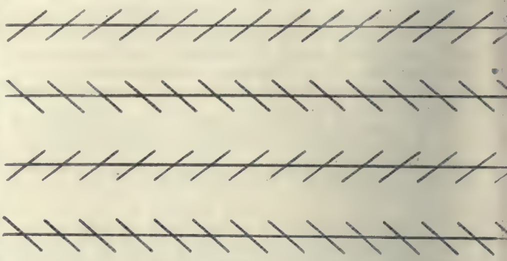

FIG. 1.

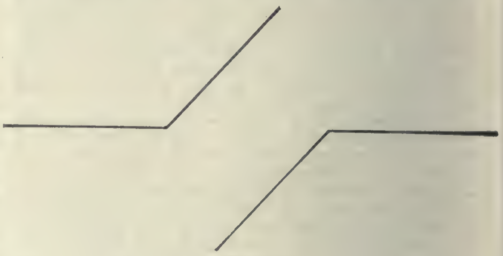

FIG. 2.

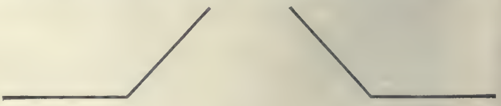

FIG. 3.

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[1] A publication, "Die leuchtenden Nachtwolken," by O. Jesse, which may be expected within the next months, will contain details regarding the entire present position of these questions.

[2] Abstract of a paper on "A Study of Zöllner's Figures and other Related Illusions," by Joseph Jastrow, Ph.D. (with the assistance of Helen West), being a part of "Studies from the Laboratory of Experimental Psychology of the University of Wisconsin."—*American Journal of Psychology*, vol. iv. No. 3.

larger the angle the greater the deviation. Similar figures with acute angles substituted for the obtuse ones would show a scarcely perceptible illusion. (2) When obtuse angles are combined with acute angles, the deviating effects of the former outweigh those of the latter. In Fig. 4 the effect of the angle ACD would be to make the line AB if continued fall *below* FG, while the effect of BCD would be to make AB fall *above* FG; the former outweighs the latter, and the illusion appears as directed by the angle ACD. The angle BCE reinforces ACD, while ACE reinforces BCD. Angles greater than 180° do not come into consideration. When all the angles about a point are equal, *i.e.*, are right angles, the illusion disappears. Figs. 5 and 6 furnish other illustrations of the same principles. In Fig. 5 the line *a* seems continuous with *c* while it is so with *b*, and this because the obtuse angles formed by lines *a* and *c* with the vertical lines respectively, deviate the lines *a* and *c* towards the direction of the angles sufficiently to bring them in line with one another. Fig. 6 adds the further complication—explicable upon the same principles—that the line is deviated once in one direction and then in the reverse direction.

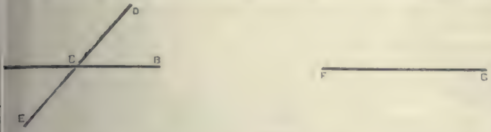

FIG. 4.

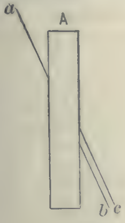

FIG. 5.

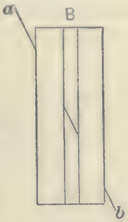

FIG. 6.

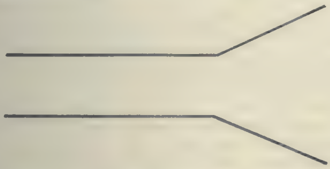

FIG. 7.

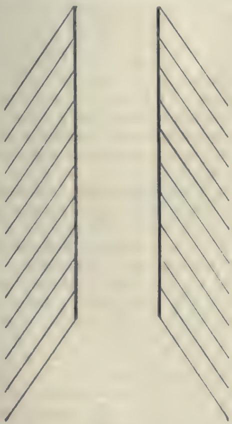

FIG. 8.

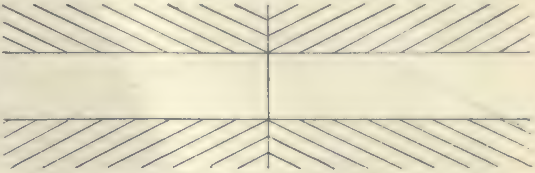

FIG. 9.

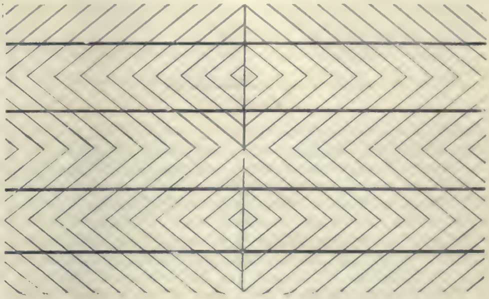

FIG. 10.

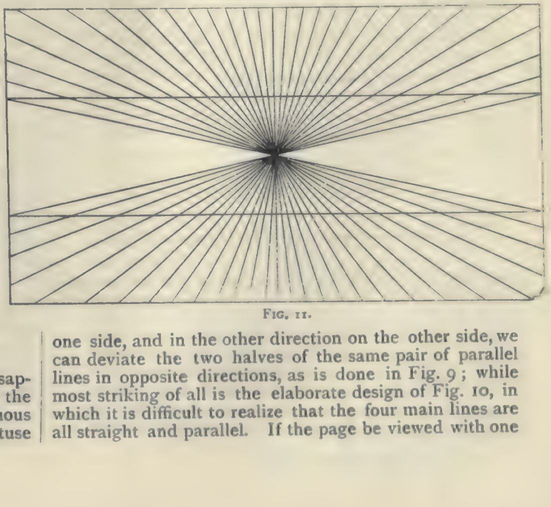

FIG. 11.

We have next to show that the illusion of deviation from parallelism is similar to that from continuity. If the right-hand portion of Fig. 3 be rotated through 180° and placed below the left-hand portion, we have Fig. 7, in which we observe a tendency for the two horizontal lines to diverge on the left and converge on the right; this is just what our dictum demands. To strengthen this illusion we add more oblique lines, and thus more angles, the obtuse angles in all cases outweighing the acute ones—Fig. 8. We have now only to draw two figures like Fig. 8, side by side, and draw the oblique lines across the vertical ones (thus keeping the figure compact) to obtain Fig. 1, with which we set out. The possibilities of illusion do not stop here; by drawing the oblique lines in one direction on one side, and in the other direction on the other side, we can deviate the two halves of the same pair of parallel lines in opposite directions, as is done in Fig. 9; while most striking of all is the elaborate design of Fig. 10, in which it is difficult to realize that the four main lines are all straight and parallel. If the page be viewed with one eye, and held horizontal nearly on a level with the eye, the true relations will appear. Fig. 11 is valuable for its conclusive demonstration that the deviation is proportional to the angle; the increasing angles gradually bend the straight lines away from one another, and give them the gradual change of direction of curves. These and other forms of illusion are all included in the generalization that the sides of an angle are deviated towards the direction of that angle.[1]

The psychological principle with which this generalization may be correlated is the law of relativity. This law emphasizes the fact that a sense-impression is not the same when presented alone and when in connection with other related sense-impressions. We cannot judge the direction of lines independently of that of the angles whose sides they form. As a further illustration of this principle it may be shown that angles will affect the apparent *lengths* of lines as well as their apparent *directions*. If in Fig. 12 we compare the horizontal portion of the uppermost figure with that of the lowest, it is almost impossible to believe that they are of equal length. The intermediate horizontal lines seem intermediate in length, and thus illustrate the fact that the apparent length of the horizontal lines is directly proportional to the size of the angles at their extremities. The illusion would persist if we converted these figures into truncated pyramids by adding a line parallel to the horizontal line, and would then illustrate the fact that equal lines may be made to appear unequal by the effect of the areas whose contours they help to form. A converse effect is illustrated in Fig. 13. Here the upper figure seems larger than the lower, because its larger parallel side is brought into juxtaposition with the smaller parallel side of the lower figure. This illusion and others show especially well when cut out of paper and held against suitable backgrounds. As the figures are moved about one another the upper constantly becomes the larger. More than two figures may be used, and a variety of such contrasts may be formed.

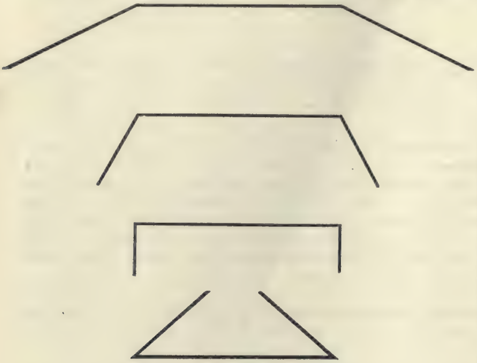

Fig. 12.

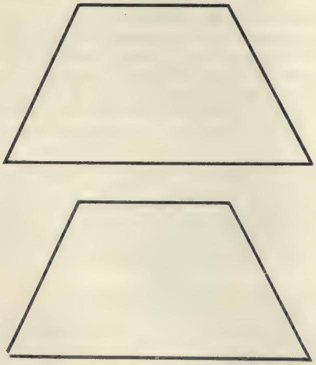

Fig. 13.

The subject is by no means fully considered in these illustrations nor is the explanation offered as final or adequate. If it seems to direct investigation into fruitful paths its chief purpose will be accomplished.

THE NEW SATELLITE OF JUPITER.

THE new number of the *Astronomical Journal* contains Mr. Barnard's account of his discovery of this additional member *of our system*. We make the following extracts:—"Nothing of special importance was encountered until the night of September 9, when, in carefully examining the immediate region of the planet Jupiter, I detected an exceedingly small star close to the planet, and near the third satellite. I at once suspected this to be a new satellite. I at once measured the distance and position-angle of the object with reference to satellite three. I then tried to get measures referred to Jupiter, but found that one of the wires had got broken out and the other loosened. Before anything further could be done the object disappeared in the glare about Jupiter. Though I was positive the object was a new satellite, I had only the one set of measures, which was hardly proof enough for announcement. I replaced the wires the next morning. The next night with the great telescope being Prof. Schaeberle's, he very kindly gave the instrument up to me, and I had the pleasure of verifying the discovery, and secured a good set of measures at elongation. In these observations, and those of the succeeding night, only distances from the following limb of Jupiter could be measured. These were observed with the wires set perpendicular to the belts. The planet was thrown outside the field, the satellite bisected, and then the limb brought in and bisected also. This method would not permit any measures from the poles of the planet for latitude. On the 12th I inserted a strip of mica, carefully smoked, in front of the field-lens, for occulting the planet. This served admirably, permitting the satellite and planet to be both seen at once, and measures from the polar limbs could be made with great ease. The observations of the satellite from the 12th were all thus made.

"To avoid any personal equation I have on each night measured the diameters of the planet, for use in reducing the observations to the centre of Jupiter. Since the 12th, these have been measured through the smoked mica, so as to avoid introducing any error from the reduced brightness of the planet. The diameters were measured by the method of double distances. Just what the magnitude of the satellite is, it is at present quite impossible to tell. Taking into consideration its position, however, in the glare of Jupiter, it would, perhaps, not be fainter than the thirteenth magnitude. It will only be possible to settle this question with any certainty by waiting until some small star of the same magnitude is seen close to Jupiter, and then after determining its magnitude when away from the planet. In general the satellite has been faint—much more difficult than the satellites of Mars. On the 13th inst., however, when the air was very clear, it was quite easy.

"It is scarcely probable that this satellite will be seen with anything less than twenty-six inches, and only with that under first-class conditions. I give here the observations that I have so far obtained, and defer any suggestions as to a name until a later paper. It certainly should not disturb the present harmony existing in the Roman numerals already applied to the satellites.

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[1] The reader is referred to the original paper for further illustration of this dictum, as well as for explanations of apparent exceptions and a discussion of the conditions affecting it.

"It is so wholly different from any of the other moons in physical aspect, that it ought, in a sense, to be considered independent of them, and simply be called, say, the fifth satellite, with a suitable mythological name.

"It will be seen that on three of the dates of observation the east elongation is well covered in the measures."

Plotting the observations at elongation, the following values of the distance were obtained:—

				From Jupiter's centre. Miles.
September 10 (apparent)	61″·04	log R =	7·08267	112250
,, 12 ,,	61″·55	,,	7·08452	112750
,, 14 ,,	61″·60	,,	7·08324	112400

From these the following periods result, using the well-known formula:—

$$P = p\sqrt{\frac{m}{M}\,\frac{R^3}{r^3}}.$$

	h.	m.
September 10 period	11	47·6
,, 12 ,, ...	11	52·3
,, 14 ,, ...	11	49·0
Mean	11	49·63

The observations, all made in standard Pacific time (eight hours slow of Greenwich) are given at length in the *Journal*.

The latitude measures show that the satellite's orbit lies in the plane of Jupiter's equator, and Mr. Barnard holds that it is consequently a very old member of Jupiter's family, "since it would doubtless take ages for the orbit to be so adjusted."

W. L.

NOTES.

THE ordinary general meeting of the Institution of Mechanical Engineers will be held on Wednesday evening, October 26, and Thursday evening, October 27, at 25, Great George Street, Westminster. The chair will be taken at half-past seven p.m. on each evening by the President, Dr. William Anderson, F.R.S. The ballot lists for the election of new members, associates, and graduates having been previously opened by the Council, the names of those elected will be announced to the meeting. The nomination of officers for election at the next annual general meeting will take place. The following papers will be read and discussed, as far as time permits:—Second Report of the Research Committee on the value of the steam-jacket, by Mr. Henry Davey, Chairman (Wednesday); and experiments on the arrangement of the surface of a screw-propeller, by Mr. William George Walker, of Bristol (Thursday).

WE are asked to intimate that the late Prof. Adams has left a number of separate copies of certain of his mathematical and astronomical papers, and that Mrs. Adams will be happy to distribute them to scientific friends who make application for them by letter addressed to her at 4, Brookside, Cambridge.

THE Harveian oration was delivered on Tuesday afternoon by Dr. J. H. Bridges. He presented an able and most interesting sketch of the scientific influences amid which Harvey's work was done, and the relation of his great discovery to later research.

THE controversy as to vivisection is still going on in the *Times*. For the present, therefore, it may be enough for us to reproduce the letter which was signed by Sir Andrew Clark, Sir James Paget, Dr. Samuel Wilks, and Sir George Humphry, and printed in the *Times* on Saturday last. It is as follows:—"Having already expressed our views, personally or by letter, to the Church Congress, we decline to enter into any further public discussion on the question of so-called 'vivisection,' for the following reasons, the statement of which we make solely because we think it is due to your readers:—Firstly, after full consideration, we are satisfied that the scientific aspect of this question cannot receive adequate and just treatment in the columns of a newspaper. Secondly, because it is hardly possible for us to name any progress of importance in medicine, surgery, or midwifery which has not been due to, or promoted by, this method of inquiry."

PROF. VIRCHOW was invested, on Saturday last, with the insignia of office as Rector of the University of Berlin. He chose "Learning and Research" as the subject of his address. He acknowledged that study had contributed greatly to create a mutual basis of understanding and a common educational foundation for the peoples of Europe, strengthening at the same time the idea of consanguinity. That state of things, however, was, he thought, entirely changed, and he contended that the turning-point in the supremacy of the classical languages had been reached. "A grammatical education is not the means for progressive development demanded by our youth. Mathematics, philosophy, and the natural sciences give young minds so firm an intellectual preparation that they can easily make themselves at home in any department of learning."

PROF. BERG has succeeded the late Dr. Burmeister as director of the National Museum in Buenos Ayres.

DR. G. V. LAGERHEIM, at present director of the Botanic Garden at Quito, Ecuador, has been appointed curator of the museum at Trömso, Norway.

MR. W. G. RIDEWOOD, B.Sc., of the Royal College of Science, South Kensington, Assistant to the Director of the Natural History Museum, has been appointed Lecturer in Biology to the St. Mary's Hospital Medical School.

THE October number of the *Kew Bulletin* opens with a section giving some interesting information as to Lao tea. Some time ago a singular method of using the leaves of what has since been proved to be the Assam tea plant of commerce (*Camellia theifera*) was brought before the Society of Arts by Mr. Ernest Mason Satow. Amongst the Laos, a people inhabiting a district of Siam, in the neighbourhood of Chiengimai, the tea leaves are not used for making an infusion as in other countries, but are prepared wholly for the purpose of chewing. The leaves are first steamed and then tied up in bundles and buried in the ground for a period of about fifteen days. Leaves thus prepared, called locally "mieng," are said to keep for two years or more. The habit of chewing "mieng" is almost universal among the Laos, and to men engaged in hard work, such as poling or rowing, it is said to be almost indispensable. The *Bulletin* prints a correspondence in which the result of an inquiry made by Kew in regard to the plant yielding "mieng" and the method of preparation is detailed.

THE other sections in the October number of the *Kew Bulletin* deal with Chinese silkworm gut; mangrove bark and extract; Burmese black rice; Mauritius tea; potato disease in Poona; British North Borneo; and Allouya tubers. There are also some miscellaneous notes.

WE learn from the *Journal of Botany* that Dr. H. Trimen, F.R.S., the Director of the Botanic Gardens at Paradeniya Ceylon, has received the sanction of the Government to proceed with the publication of the flora of that island. The work will be published in parts by Messrs. Dulau and Co., and will form two vols. octavo, together with a quarto atlas of 100 coloured plates, drawn by the native Cingalese artists attached to the gardens. The first part is now in the press. The book is more especially designed for use in the colony, and will enter into more local detail than has been hitherto the practice in the Colonial floras published by the Government.

MR. G. HOGBEN delivered an excellent address lately before the Canterbury College Science Society, New Zealand, on earthquakes. In the course of his remarks he described the system which, for the last three years, has been in force in New Zealand for the observation of earthquake phenomena and the telegraphing of the results to a central station. This system has been adopted in Victoria, New South Wales, South Australia, and Tasmania, and will probably be shortly adopted in Queensland. The various colonies exchange reports with New Zealand, and it is proposed that the system shall be further extended, so that the colonies may be brought into communication with the islands of the Pacific and America and Japan.

A REUTER telegram despatched from Vienna on October 14 announced that reports had reached that city of the occurrence of violent earthquake shocks in Eastern Europe. The vibrations were strongest in Roumania, being felt at Bucharest, where they lasted 15 seconds, and at Galatz during 30 seconds. At Oltenizza the shock lasted fully 90 seconds, and did considerable damage in the town. A shock was felt at Sofia on October 14, at seven o'clock A.M., and also at Philippopolis, Varna, and Rustchuk. The seismic wave passed from south to north, the vibration lasting several seconds, and being accompanied by subterranean rumbling.

THE depression over the Bay of Biscay referred to in our last issue took a very unusual route, the track being almost circular, moving first in an easterly and north-easterly direction towards the north of France, and then recurving by the south-west of England back to the Bay of Biscay, when it again travelled to the eastward. The disturbance caused to the weather in this country was very great and the rains were very heavy, with serious floods, especially in Wales and the midland and northern counties. In Yorkshire it rained almost incessantly from Thursday to Saturday, a fall of 1¾ inch being measured in one day. The weather was still further disturbed by an area of low pressure lying over the north of Germany between Sunday and Monday, which caused disastrous gales and further heavy rains in the eastern part of the country. The temperature has been very low for the season, the daily maxima scarcely reaching 55° in any part of the kingdom, owing to the persistent northerly and north-easterly winds. Towards the close of the period temperature fell several degrees lower, with sharp day frosts in Ireland, under the influence of an anti-cyclone, which spread over the country from the Atlantic, while hail and sleet showers fell in places. The *Weekly Weather Report* of the 15th inst. showed that the temperature of the past week was everywhere below the mean, being as much as 4° in the south-west of England and 5° in the south of Ireland. The rainfall greatly exceeded the average over the north and east of England.

AN anemometer by M. Timchenco of a novel construction is described by Prof. Klossovsky, of the Odessa Observatory, by which both the wind direction and velocity are marked on a cylinder by one symbol. The recording apparatus is moved by clockwork and the indications are made by electrical contacts. The duration of the contact depends upon the velocity of the wind, a light wind producing a contact of longer duration than a strong one. The indications are by means of arrows printed on the paper covering the cylinder, which show the direction of the wind, and the number of arrows marked on a length of paper corresponding to one hour furnishes data for finding the velocity by an empirical scale determined by comparison with a Robinson's anemometer. The apparatus only requires to be adjusted twice a month, or in some instruments only once a month, and calls for no attention in the meantime. A battery cell is sufficient to produce the contact, for most of the work is done by means of weights.

THE *Annuaire* of the Municipal Observatory of Montsouris for the years 1892–93 contains, in addition to the usual tables showing *inter alia* the extremes of temperature at Paris since 1699 and the monthly rainfall values since 1690, much useful information with reference to the climate and the microscopic examination of the quality of the air. Although it does not fall within the province of the observatory to issue weather forecasts, applications for such information are sometimes received and answered, in the interest of agriculture. The opinion is expressed that by basing the calculations on the general methods adopted by Laplace in his memoir entitled "Probabilité des causes d'après les événements," it is not impossible to give a long forecast which may be at times of much use. Some interesting remarks are also made as to the possibility of foreseeing the character of the summer from the weather experienced in the early spring, based chiefly on the time of the appearance of the north-east winds, and the differences in their usual strength and physical qualities, in connection with the transparency of the air. The results of the analysis of the air show that the minimum amount of carbonic acid occurs between May and September, and that the amount at night is greater than during the day.

THE new University of Chicago has decided that its work shall go on all the year through, including the summer months. According to the New York *Nation*, the calendar year is divided into four quarters of twelve weeks each, beginning respectively on the first days of October, January, April, and July; and at the end of each quarter there is to be a recess of one week. Each quarter consists of two terms of six weeks. No student is to be held to an attendance of more than three quarters, or six terms, in each year, so that the normal academic year is no longer than at other colleges. Each student is to begin his academic year whenever he is ready, and to take his quarter's vacation whenever it suits his convenience. He may even take his two terms of vacation in different quarters.

AN investigation of the phenomena exhibited at the negative poles of vacuum tubes appears in vol. xl. of the *Sitzungsberichte* of the Prussian Academy. Professor E. Goldstein considers that the term "stratification" as applied to the light at the cathode is a misnomer, since two at least of the strata can be shown to pervade the entire region of luminosity. The light nearest the cathode is yellowish, and about 1 cm. thick. Next comes Crookes' "dark space," which in reality shines with a faint blue light. Then follows the third and most highly luminous layer, whose colour changes from a blue to a violet as the exhaustion is carried further. The first layer was shown to be a separate phenomenon on a previous occasion. The so-called second layer shows the peculiarity of rectilinear propagation. It is emitted from the electrode normally to its surface, or very slightly divergent, whereas that of the third layer spreads throughout the bulb and even passes round corners. The second layer is best shown by concave poles, which concentrate the light at the centre of curvature. If observed through a blue glass, which cuts off the third layer, it is seen to diverge from the focus and impinge upon the wall of the bulb. The phosphorescence observed in the glass where it is struck by the "radiant matter" is due to this part of the light only, and not to the third layer. It is this also which produces the well-known phenomena of shadows. A glass rod laid in its path casts a shadow through the blue space, which is, however, relieved by the purple luminosity of the third layer. The former is also the only light deflected by a second cathode. It is to be concluded that the light at the negative pole of a vacuum tube consists of three different species, each pervading the others, but having distinct and characteristic properties of its own.

IN the current number of the "Annals of Scottish Natural History," Mr. E. P. Knubley discusses the question whether legislative protection is required for wild birds' eggs. He suggests that the most practicable plan might be for Parliament to grant powers to the County Councils from time to time, and as necessity arose, to place certain portions of a district, such as mountains, commons, waste places, lakes and meres, or portions of cliffs or foreshores, under an Act for specified months in the year—say, from April 1 to June 30. What, however, is most urgently wanted, as Mr. Knubley says, is that landlords and occupiers shall, as far as possible, protect birds breeding on their property or "occupation."

MR. ERNEST ANDERSON recently read before the Field Naturalists' Club of Victoria an interesting paper on some Victorian Lepidoptera. He said that a great charm accompanied the rearing out of the Victorian species, because the results were very frequently of a most unlooked-for character. The Victorian forms followed the same rule as many plants and animals in having characteristics and habits purely Australian; and not only so, but they helped to bridge over the sharply-defined divisions known in Europe, and merged the various groups so imperceptibly into each other that it was hard to say where one ended and another began. Speaking of the processional caterpillars (*Teara melanosticta*), Mr. Anderson described how a female laid some ova in a small box and covered them very thickly with yellow down. Very shortly afterwards a thread-like structure was visible, which close examination revealed to be composed of newly-hatched caterpillars in Indian file, each having its head close up to the tail of its forerunner, and the whole line moving simultaneously with mathematical precision.

THE use of gas engines does not seem to be nearly so common in the United States as in Great Britain. According to the *Railroad and Engineering Journal*, they are generally regarded in America as of service for light work only, and it is with some surprise that our contemporary has noted the advertisement of an English firm, which keeps all sizes up to forty-horse-power in stock, and offers to furnish single engines of any size up to two-hundred-and-fifty-horse-power. This much exceeds the capacity of any gas engine built until very recently.

THE U.S. Department of Agriculture has published a valuable account, by Harvey W. Wiley, of experiments with sugar-beets in 1891. The experiments were divided into three classes; (1) culture of the sugar-beet conducted by farmers in different parts of the country; (2) culture of the sugar-beet conducted by the agricultural experiment station of Wisconsin and numerous farmers in Wisconsin, under the direction of the agricultural experiment station of that State, by authority of the Secretary of Agriculture; (3) experiments conducted at the beet-sugar experiment station of the Department at Schuyler, Nebraska.

WE learn from the *American Naturalist* for October that the vertebrate fossils collected by Prof. Marsh, to which we lately referred, are not likely, after all, to be soon exhibited in the National Museum at Washington. Our contemporary says: "One side of a small room is the only space at present occupied by the material in question, and it is safe to say that no other space has been yet provided. As the National Museum committed the error at its establishment of attempting an exhibit of modern human industries, as we pointed out at the time, the space for scientific exhibits is necessarily greatly curtailed. The necessities of this department require the erection of a new building, and until that is done it is safe to say that the vertebrate collections of the U.S. Geological Survey will not be exhibited."

SLEEP is one of the least understood of physiological phenomena. A new theory of it (we learn from the *Revue Scientifique*) has been offered by Herr Rosenbaum. He supposes the essential fact in the fatigue of the nervous system leading to sleep to be a hydratation of the nerve-cells, an increase of their water-content. The greater the hydratation, the less the irritability. This hydratation arises through chemical change of the nervous substance during activity. A small part of the water escapes by day through the lungs, but the greater part is eliminated during sleep. Its passage into the blood takes place by virtue of the laws of diffusion, and depends on the quantity and density of the blood, its amount of fixed principles, its speed of flow, &c. Elimination of the expired air takes place according to the laws of diffusion of gases. The assimilable substances of the body take the place of the water eliminated in sleep. The repair of the physical and mental forces through sleep is due to this elimination and replacement. Intelligence is in inverse ratio of the proportion of water in the brain, and may be measured by this proportion, at least in the child. It may be doubted whether this theory explains the sleep of hibernating animals, or that caused by opium and anæsthetics.

D. J. MADISON TAYLOR has been elaborately investigating the various problems relating to physical exercise in health and as a remedy, and some of the results are set forth in the *Journal of the Franklin Institute* for September and October. One conclusion is, he says, uniformly prominent in the instances of damage from boat and other racing. Always the training has been "either insufficient or bad, or both."

IN one of the papers contributed to the third number of the Trinidad Field Club's Journal, Mr. J. Edward Tanner describes some interesting observations of the habits of the Parasol or Leaf Cutting Ants. Two nests of these ants were on his table at the time when his paper was being prepared. He begins by noting that all in Trinidad who are interested in such subjects know the hurried manner in which a parasol ant returns to her nest (all leaf-cutting workers are females), bearing erect in her mandibles the portion of leaf she has herself just cut off, and apparently running home with it in triumph. These foragers, for they are the ones who supply the household, carry their portion of a leaf well into the nest, drop it, and return for another piece, nor do they cease doing so till the supply is more than those in the nest require. Mr. Tanner could not induce the ants in one of his nests to carry any leaf whatsoever into the nest, till one day he coaxed a small worker to do so. As she entered she was caressed by those in the nest, who stroked and patted her with their antennæ. The small piece of leaf she had brought was at once taken by one of the larger workers, to go through its various processes, while she returned for more, and she continued to bring in pieces till late in the evening. Strange to say, none of the others followed her example. Even four weeks later only two or three carried in any portions of leaf. Mr. Tanner suggests that this may have been due to the fact that the queen was accidentally killed while the nest was being taken. The other nest had a queen, and with it there was no trouble, for the ants kept themselves well supplied from whatever was offered to them on their feeding ground, whether rose leaves, plumbago, or quis-qualis. "Each forager," says Mr. Tanner, "drops her portion of leaf in the nest, which is taken up as required by the small workers, and carried to a clear space in the nest to be cleaned. This is done with their mandibles, and if considered too large it is cut into smaller pieces. It is then taken in hand by the larger workers, who lick it with their tongues. Then comes the most important part, which almost always is done by the larger workers, who manipulate it between their mandibles, mostly standing on three legs. The portion of leaf is turned round and round between the mandibles, the ant using her palpi, tongue, her three legs, and her antennæ while doing so. It now becomes a small, almost black ball, varying in size from a mustard seed to the finest dust shot, according to the size of the piece of leaf that had been manipulated. The size of the piece of leaf is from an $\frac{1}{8}$ by $\frac{1}{8}$ of an inch, by $\frac{1}{4}$ by $\frac{1}{4}$ of an inch. I do not wish it to be understood that only one class of workers manipulate the leaf, for all seem to take to it very kindly on emergency. Even the smallest workers will bring their tiny ball to where the fungus bed is being prepared. These balls, really pulp, are built on to an edge of the fungus bed by the larger workers, and are slightly smoothed down as the work proceeds. The new surface is then planted by the smaller workers, by slips of the fungus brought from the older parts of the nest. Each plant is planted separately and they know exactly how far apart the plants should be. It sometimes looks as if the plants had been put in too scantily in places, yet in about forty hours, if the humidity has been properly regulated, it is all evenly covered with a mantle, as if of very fine snow. It is this fungus they eat, and with small portions of it the workers feed the larvæ."

MR. O. P. HAY records in the latest volume of the Proceedings of the U.S. National Museum a curious habit of horned toads. Some years ago two boys from Texas, whose family had moved into his neighbourhood, showed him a few lizards belonging to the genus Phrynosoma, and popularly called horned toads. The boys declared that these little animals, when teased, would sometimes squirt blood out of their eyes. Mr. Hay did not think much about the matter at the time, but was lately vividly reminded of it in the department of reptiles in the National Museum. Near his desk there was a specimen of *Phrynosoma coronatum*, which had been sent from California by a member of Dr. Merriam's exploring party. About August 1 it was shedding its outer skin, and the process appeared to be a difficult one, since the skin was dried and adhered closely. One day it occurred to Mr. Hay that it might facilitate matters if he gave the animal a wetting; so, taking it up, he carried it to a wash-basin of water near by and suddenly tossed the lizard into the water. "The first surprise," says Mr. Hay, "was probably experienced by the Phrynosoma, but the next surprise was my own, for on one side of the basin there suddenly appeared a number of spots of red fluid, which resembled blood." He immediately recalled what the boys had told him of the ability of horned toads to squirt blood, and he concluded that this was a good time to settle the question whether this fluid was blood or not. A microscope was soon procured and an examination was made, which immediately showed that the matter ejected was really blood. A day or two afterwards Mr. Hay was holding the lizard between his thumb and middle finger, and stroking its horns with his forefinger. All at once a quantity of blood was thrown out against his fingers, and a portion of it ran down on the animal's neck; and this blood came directly out of the right eye. Mr. Hay has since found that the phenomenon has been noticed by other observers, and, while he was preparing his paper, his attention was called to the fact that more than twenty years ago Mr. A. R. Wallace read before the Zoological Society of London letters from a correspondent in California, who described this creature as squirting from one of its eyes "a jet of bright red liquid very much like blood."

MESSRS. PERCIVAL AND CO. announce the following works:—"Geometrical Drawing," by A. J. Pressland; "Lessons on Air," by A. E. Hawkins; "The School Euclid," an edition of Euclid, Books i.–vi., with Notes and Exercises, by Daniel Brent; and a series of elementary text-books entitled "The Beginner's Text-books of Science," of which Mr. G. Stallard is the general editor.

MESSRS. GEORGE BELL AND SONS have published a second edition of Mr. A. J. Jukes-Browne's "Student's Handbook of Physical Geology." The author explains that in preparing this edition he has spared no pains to make it a trustworthy handbook for those branches of the science to which it relates.

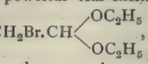
MESSRS. WHITTAKER AND CO. have issued for the benefit of amateur coil-makers a practical manual on "Induction Coils," by G. E. Bonney. The author's object has been to place in the hands of his readers "a cheap and handy volume giving a general insight into the construction of ordinary spark coils, medical coils, and batteries for working them." There are more than a hundred illustrations.

MESSRS. LONGMANS, GREEN, AND CO. have issued a new edition, revised and largely re-written, of the well-known "Outlines of Psychology," by Prof. James Sully.

MESSRS. CHAPMAN AND HALL will shortly publish a work by Rev. H. N. Hutchinson, entitled "Extinct Monsters." It will be illustrated by Mr. J. Smit, who has made twenty-four restorations of antediluvian animals. The book is not intended for geologists only, but for all who are interested in the study of animal life. Dr. Henry Woodward, F.R.S., keeper of geology, Natural History Museum, contributes a preface.

THE new number of *Records of the Australian Museum* (Vol. III., No. 2) opens with a paper, by Mr. J. Douglas Ogilby, on some undescribed reptiles and fishes from Australia. To the same number Mr. C. Hedley contributes a paper on the structure and affinities of *Panda Atomata*, Gray. Mr. A. North has a note on *Manucodia comrii*, Sclater.

THE University College of North Wales has published its calendar for the year 1892-93.

GLYCOL aldehyde, $CH_2OH.CHO$, the hitherto almost unknown first aldehyde derived from glycol, forms the subject of a communication to the current number of the *Berichte* by Prof. Emil Fischer and Dr. Landsteiner. This substance acquires additional interest when the ordinary sugars are defined as aldehyde- or ketone-alcohols, for it then becomes the first member of the series. Prof. Fischer now shows how glycol aldehyde may readily be obtained, discusses its properties, and points out that by its polymerisation a new sugar is obtained, tetrose, the first synthetical sugar containing four atoms of carbon. The only evidence hitherto published of the existence of glycol aldehyde is that afforded by the work of Abeljanz and Pinner. The former chemist considered that he had obtained it by heating di-chlor-ether with water, and by the action of sulphuric acid upon mono-chlor-hydroxy-ether. But upon repeating the work of Abeljanz, Prof. Fischer finds that the substance considered, upon very slight evidence, to be glycol aldehyde is another compound altogether. Pinner afterwards attempted to obtain it by decomposition of a substance discovered by him, glycol acetal, with acids, but Prof. Fischer finds that this reaction only occurs under conditions such that the glycol aldehyde is itself also decomposed. In view of the formation of glyceryl aldehyde by the action of baryta upon acroleïn dibromide, a reaction now of historical importance as being the one which led Prof. Fischer to the first synthesis of grape sugar, it was thought probable that glycol aldehyde might be similarly obtained by the action of baryta upon the mono-bromine derivative of aldehyde, $CH_2Br.CHO$. Mono-brom-aldehyde, however, had never been hitherto obtained, so Prof. Fischer and Dr. Landsteiner first sought a method for its preparation. They eventually obtained it, as a viscid colourless liquid of powerful tear-exciting odour, by heating mono-brom-acetal,  $CH_2Br.CH\left<\begin{matrix}OC_2H_5\\OC_2H_5\end{matrix}\right.$, with anhydrous oxalic acid. When the mono-brom-aldehyde thus obtained was mixed with water containing barium hydrate partly in solution and partly in suspension, and the whole maintained for half an hour at 0°, the odour of the brom-aldehyde disappeared almost completely. Upon removal of the baryta by sulphuric acid and the hydrobromic and sulphuric acids by lead carbonate, the filtered liquid was found to contain glycol aldehyde, which could be concentrated by evaporation over oil of vitriol *in vacuo*. The solution of glycol aldehyde reduces Fehling's solution with great energy at the ordinary temperature. When warmed with a solution of phenylhydrazine in acetic acid crystals of an osazone are deposited, just as happens in the case of other members of the series of sugars. Glycol aldehyde is readily oxidized by bromine water to glycollic acid, $CH_2OH.COOH$. When treated with a dilute solution of sodium hydrate polymerization occurs, a sugar of the composition $C_4H_8O_4$, the first synthetical tetrose, being formed, which is readily isolated in the form of its osazone (phenyl. hydrazine compound). This osazone appears to be identical with one obtained by Prof. Fischer from one of the oxidation products of natural erythrite. The preparation of glycol aldehyde completes the synthesis of the whole of the members of the series of sugars, from the first member up to the sugars containing nine atoms of carbon, with the exception of pentose. This latter sugar Prof. Fischer hopes shortly to obtain from the tetrose above described.

THE additions to the Zoological Society's Gardens during the past week include a Grivet Monkey (*Cercopithecus griseo-viridis* ♀) from Zanzibar, a Bengal Fox (*Canis bengalensis*) from Pondicherry, presented by the Rev. J. W. Scarlett; a —— Monkey (*Cercopithecus sp. inc.*) from the Zambesi, presented by Mr. Joseph A. Moloney; a Bonnet Monkey (*Macacus sinicus*) from India, a White Stork (*Ciconia alba*), European, presented by the Rev. Sidney Vatcher; a Mona Monkey (*Cercopithecus mona*) from West Africa, presented by Miss Synge; a Hairy Armadillo (*Dasypus villosus*) from South America, presented by Mr. J. H. Hamilton Benn; a Common Badger (*Meles taxus*), British, presented by Mr. W. Butler; a —— Galago (*Galago sp. inc.*) from East Africa, presented by Mr. Thomas E. C. Remington,; an —— Ichneumon (——), a Purple-crested Touracou (*Corythaix porphyreolophus*), two Black Gallinules (*Limnocorax niger*), a Tambourine Pigeon (*Tympanistria bicolor*), an Emerald Dove (*Chalcopelia afer*), four Half-collared Doves (*Turtur semitorquatus*), a —— Fruit Pigeon (*Treron sp. inc.*), four —— Tree Frogs (*Hylambates maculatus*), seven Smooth-clawed Frogs (*Xenopus lævis*) from East Africa, presented by General Mathews; three Mitred Guinea Fowls (*Numida mitrata*), a —— Snake (*Philothamnus semivariegatus*) from East Africa, presented by Mr. W. Hall Buxton MacDonald, M.D.; a —— Pratincole (*Glareola sp. inc.*), a Half-collared Dove (*Turtur semitorquatus*), a Nilotic Crocodile (*Crocodilus niloticus*) from East Africa, presented by Mr. R. MacAllister; two —— Francolins (*Francolinus* ——), a —— Coucal (*Centropus* ——), five Half-collared Doves (*Turtur semitorquatus*) from East Africa, a Black-tailed Hawfinch *Coccothraustes melanurus*) from Japan, presented by Mr. F. Pordage; a Flap-necked Chameleon (*Chamæleon dilepis*), two Square-marked Toads (*Bufo regularis*) from East Africa, presented by Mr. E. Millar; a Galeated Pentonyx (*Pelomedusa galeata*), two —— Skinks (*Gerrhosaurus major*), five —— Geckos (*Hemidactylus mabouia*), three —— Lizards (*Mabuia striata*) from East Africa, presented by Mr. Frank Finn, F.Z.S.; a Common Quail (*Coturnix communis*), captured at sea, presented by Mr. A. Torrie; a Honey Buzzard (*Buteo apivorus*) from France, presented by M. S. A. Pichot C.M.Z.S.; a Burrowing Owl (*Speotyto cunicularia*) from South America, presented by Mr. R. B. Shipway; two Common Boas (*Boa constrictor*) from Trinidad, presented by Messrs. Mole and Urich; a Black-headed Lemur (*Lemur brunneus*) from Madagascar, a Yellow-tailed Rat Snake (*Spilotes corais*) from Trinidad, deposited; an African Wild Ass (*Equus tæniopus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

A NEW COMET.—A telegram from Kiel announces the discovery of a new comet by Prof. Barnard on October 12 last, at 17h. 12·2m. mean Lick time. The position, as therein stated, was R.A. 293° 29′, and Declination + 12° 33′. As this new comet is termed "very dim," as seen with the large Lick refractor, it is needless to say that few instruments can at present observe it.

OUR SUN'S HISTORY.—The question of "How our Sun commenced to grow hot," is the subject of an article by Lord Kelvin in the October number of *L'Astronomie*. In these few pages he deals with various questions, among which may be mentioned: What is the temperature of the Sun? Is it increasing or diminishing? What was the state of the matter constituting our Sun before it was united into a single mass and began to grow hot? The answer to the last question leads him into the method of construction of our solar system. In considering the question of the encounter between two bodies as the origin, he finds that the probability of such an encounter between two neighbouring stars belonging to a large number of bodies, attracting one another mutually, and scattered in space, is much greater if they are at rest than if they are moving, even if their velocities are greater than those acquired in falling from rest. As an explanation of this Lord Kelvin takes the case of two solid and cold bodies of diameters equal to half that of the sun, and of mean densities equal to that of the earth, and supposes them at rest, the mean distance between each other being that of the earth from the sun. The collision caused by mutual attraction will transform the bodies into a fluid, incandescent mass, and he describes how this mass will arrange itself round this surface of collision. The next case he takes is similar to the one above, only the bodies have originally considerable velocities. Further on, as a special instance, he assumes the presence of 29 millions of solid cold globes, each having a mass equal to that of our moon, and the total masses of which are equivalent to that of our sun. These bodies, absolutely at rest, are supposed to be disseminated uniformly on the surface of a sphere (radius = terrestrial orbit), and allowed to fall towards the centre of the sphere by attraction. The result, to state briefly, is a mass of highly heated vapour, which afterwards expands and contracts consecutively, forming a gaseous nebula, measuring forty times the radius of the terrestrial orbit. By supposing that, instead of absolute rest at the commencement, these moons have a certain movement, the total sum of which represents a moment of rotation round a certain axis, equal to the moment of rotation of the solar system, this nebula would be a more or less facsimile of our solar system in its earlier stage, as figured out by La Place for his nebular theory. Thus this theory, "founded by La Place on the history of the sidereal universe such as Herschel observed, and completed in its details by his profound dynamical judgment and imaginative genius, appears to-day a truth demonstrated by thermodynamics." For the theory of the sun, Lord Kelvin says in conclusion that the antecedents immediately before incandescence cannot be definitely stated, since the latter may have been caused by large and few bodies, or by agglomerations of such bodies as meteorites.

SILVERING GLASS MIRRORS. — Mr. Common, in the *Observatory* for October, gives a brief account of various processes and methods for producing good reflecting surfaces. In the short historical sketch we find that the modern process is due to an observation of Baron Liebig, who, in 1835, found that on heating aldehyde with an ammoniacal solution of silver in a glass vessel a brilliant deposit of metallic silver was deposited on the surface of the glass. In all the methods used up till quite recently the surface to be silvered had to be suspended over the bath, owing to the formation of mud which settles down and prevents the proper deposition of silver; thus really large surfaces could not be dealt with. This was the case with Mr. Common's 3-foot, a pneumatic arrangement being made to hold the mirror by the back. In dealing with the 5-foot, this method could not be so easily applied, and experiments were made to find some means by which this "mud" could be entirely eliminated. This was successfully done by omitting the potash from the bath. One curious fact of observation is that the mirrors experimented on never seemed to take the first application of the silvering solution, but on being recleaned with nitric acid the second was always successful. Why this should be so does not seem to be easily explained, for Mr. Common only commits himself to the statement that "the nature of the liquid other than distilled water last in contact with the surface of the mirror seems to be the determining thing."

Himmel und Erde.—In this magazine for October there is a most interesting set of articles, of which we mention the following:—"Meteorology as the Physics of the Atmosphere," by Herr Wilhelm von Bezold. This comprises a general summary of the proceedings of the German Meteorological Society, which met in Braunschweig on June 7 last.—"Astronomy of the Invisible," by Herr Dr. Scheiner. This is the first of a series of articles, and deals, as far as it goes, with the discovery of Neptune by Adams and Le Verrier; it contains also a translation of the letter which Le Verrier wrote to Dr. Galle, who was then an assistant at the Berlin Observatory, telling him the results he had obtained, and asking him to make a search for the unknown planet. As a matter of interest we will give the elements of Neptune as obtained by Le Verrier and Adams, together with the true ones afterwards determined, for the results of such a piece of work will always be looked upon with interest.

	Le Verrier.	Adams.	True elements.
Half major axis	36·15 ...	37·25 ...	30·05
Eccentricity	0·1076 ...	0·1206 ...	0·0090
Longitude of Perihelion ...	285° ...	299° ...	46°
Mass (Sun = 1)	0·0001 ...	0·00015 ...	0·00005
Inclination	0° ...	0° ...	1°·8

In the notes two excellent illustrations of parts of the moon are inserted, one being a reproduction of a photograph taken at the Lick Observatory on August 31, 1890, and the other displaying the region to the north of Hyginus, showing these curious river-like appearances as first remarked by Prof. Weinek of Prague. Other notes deal with the astronomical reasons of the Ice Age, observations of Mars during the period 1883–88, polariscope observation of the surface of Venus, &c.

GEOGRAPHICAL NOTES.

MOUNT ORIZABA, or Citlaltepetl, in Mexico, has been measured trigonometrically by Mr. J. T. Scovell, with the result that its height is fixed as 18,314 feet. Popocatepetl is about 700 feet lower, and unless Mount St. Elias is found to considerably exceed Russel's estimate of 18,100 feet, Orizaba must be considered the highest summit in North America.

THE pumping of brine from the North German salt mines and the consequent subsidence of the land, is the cause of a somewhat interesting change in the small lakes near Mansfeld. The Salzigen See, as observed by Dr. Ule, of Halle, had a maximum depth of thirty metres on June 18, and of no less than forty-two metres on June 28, the subsidence of the bottom having taken place at the average rate of more than one metre a day.

FOLLOWING the death of Dr. Theodor Menke (see p. 302) we have to notice the loss of his fellow-worker, Dr. Karl Spruner von Merz, at the age of eighty-nine. He died on August 24, 1892. After a military career of some distinction, he retired from the army in 1886. His attention was early attracted to historical geography, and his famous "Historical Atlas" (1837–1852) has made his memory imperishable. It was in preparing the third edition of this atlas that he was first associated with Menke.

THE camels which were introduced into German South-West Africa last year, have, according to the *Deutsches Kolonialblatt*, proved a great success. They are employed in keeping up communication between Walfisch Bay and Windhoek, and for journeys into the interior. Their power of travelling for a week at a time without food or water has frequently been put to the test on the borders of the Kalahari desert. The climate does not seem to affect them unfavourably, and they have proved exempt from the many fatal diseases which attack horses and even oxen in Namaqualand.

A LECTURE on "Regions and Races" was delivered on Monday evening in the Regent's Square Hall by Dr. H. R. Mill. The object of the lecture was to demonstrate the continuity of geography with the physical sciences which account for the growth of the surface features of the globe, and with the natural sciences which explain the forms of plant and animal life on its surface. The interactions between man and his environment were discussed as the true basis of the higher geography.

M. J. THOULET has this summer been engaged in an oceanographical study of the Basin of Arcachon, and publishes in the last number of the *Comptes Rendus* an interesting epitome of his preliminary results. This lagoon forms a valuable oyster preserve, and the researches into the action of the tides on the enclosed water has practical as well as scientific bearings. The investigation will be continued, so as to include the other lagoons along the coast enclosed by sand dunes, and more or less cut off from the sea.

THE COMPARATIVE PHYSIOLOGY OF RESPIRATION.[1]

AMONG the very first of the physiological acts observed were those of respiration. The regular movements of breathing, from the first feeble efforts of the new-born babe until the sigh in the last breath of the dying—after which is silence, cold, and dissolution—have commanded the attention and claimed the interest of every one, the thoughtful and the thoughtless alike. And one comes to feel that in some mysterious way "the breath is the life." But in what way does breathing subserve life or render it possible? Aristotle and the naturalists of the olden time supposed that it was to cool the blood that the air was taken into the lungs, and, as they supposed, also into the arteries. With the limited knowledge of anatomy in those early days, and the fact that after death the arteries are wholly or almost wholly devoid of blood, while the veins are filled with it, what could be more natural than to suppose that the arteries were vessels for the cooling air? If one supposes that he has entirely outgrown this view of Aristotle, let him think for a moment how he would express the fact that an individual is descended from the Puritans, for example. In expressing it even the physiologist could hardly bring himself to say other than "he has the blood of the Puritans in his veins." Would he say "he has the blood of the Puritans in his arteries"?

As observation increased the cold-blooded animals were more carefully studied and found to possess also a respiration; they certainly do not need it to cool the blood. Then there are the insects and the other myriads of living forms that teem in the oceans, lakes, rivers, and even in the wayside pools. Do these, too, have a breath? And the plants on the land and in the water, is the air vital to them? Aristotle and the older naturalists could not answer these questions. To them, on the respiratory side at least, all life was not in any sense the same. It was not till chemistry and physics were considerably developed, not until the air-pump, the balance, and the burette were perfected that it was possible to give more than a tentative answer. It was not, until the microscope could increase the range of the eye into the fields of the infinitely little, possible to form even an approximately correct conception. The first glimmerings of the real significance of respiration for all living things was in the observation that the air which would not support a flame, although it might be breathed, could not support life. That is, there must be something in the transparent air that feeds the flame and becomes the breath of life, the real *pabulum vitæ*, the merely mechanical action of the air not being sufficient.

Since the experiments on insects and other animals by Boyle (1670) with the air-pump, by Bernouilli, on subjecting fishes to water out of which all the air had been boiled, and those of Mayow (1674), it became more and more evident that respiration was not confined to the higher forms, but was a universal fact in the organic world. Then came the most fruitful discoveries of all, made by the immortal Priestley (1775–6), viz., that the air is not an element, but composed of two constituents—nitrogen, which is inert in respiration, and oxygen, which is the real vital substance of the air, the substance which supports the flame of the burning candle and the life of the animal as well.

What would seem more simple at this stage of knowledge than that the parallel between the burning candle and the living organism should be thought to represent truly the real conditions? That as the candle consumes the oxygen, burns, and gives out carbon dioxide, so the living thing breathes in oxygen, and gives out in place of that consumed carbon dioxide. And as in each case heat is produced, what would be more natural than to look upon respiration as a simple combustion? This was the generalization of Lavoisier (1780–89). As he saw it, the oxygen entered the lungs, reached the blood, and burned the carbonaceous waste there found, and was immediately given out in connection with the carbon with which it had united, and as the gas given off in a burning candle makes clear lime-water turbid, so the breath produces a like turbidity.

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[1] Address delivered, in August, 1892, at the meeting of the American Association for the Advancement of Science, by Prof. Simon Henry Gage, of Cornell University, Ithaca, N.Y., Vice-President of the Biological Section

But here, as in many of the processes of nature, the end products or acts were alone apparent, and while the fundamental idea is probably true that respiration is, in its essential process, a kind of combustion or oxidation, yet the seat of this action is not the lungs or blood. If the myriads of microscopic forms are considered, these have no lungs, no blood, and many of them even no organs; they are, as has been well said, organless organisms, and yet every investigation since the time of Vinci and Von Helmont, Boyle and Mayow, has rendered it more and more certain that every living thing must in some way be supplied with the vital air or oxygen, and that this is in some way deteriorated by use; and the nearer investigation approaches to the real life-stuff or protoplasm, it alone is found to be the true breather, the true respirer, as was shown long ago by Spallanzani (1803–7). If one of the higher animals, as a frog, is decapitated and some of its muscle or other tissue exposed in a moist place, it will continue to take up oxygen and give out carbon dioxide, thus apparently showing that the tissues of the highly organized frog, may, under favourable conditions, absorb oxygen directly from the surrounding medium, and return to it directly the waste carbon dioxide. This shows conclusively that it is the living substance that breathes, and the elaborate machinery of lungs, heart, and blood-vessels, are only to make sure that the living matter, far removed from the external air, shall not be suffocated. Still more strange, it has been found that if some of the living tissue is placed in an atmosphere of hydrogen or nitrogen entirely devoid of oxygen, it will perform its vital functions for a while, and although no oxygen can be obtained, it will give off carbon dioxide as in the ordinary air. If it is asked, "how can these things be?" the answer is apparently plain and direct. Not as the oxygen unites directly with the carbon in the burning candle does it act in the living substance. The oxidations are not direct in living matter, as in the candle; but the living matter first takes the oxygen and makes it an integral part of itself, as it does the carbon and nitrogen and other elements; and, finally, when energy is to be liberated, the oxidation occurs, and the carbon dioxide appears as a waste product.

The oxygen that is breathed to-day, like the carbon or the nitrogen that is eaten, may be stored away and represent only so much potential energy to be used at some future time in mental or physical action.

So far only living animal substance has been discussed. If plants are considered, what can be said of their relations to the air? The answer was given in part by Priestley (1771), who found that air which had been vitiated by animal respiration became pure and respirable again by the action of green plants. He thus discovered the harmonizing and mutual action of animals and plants upon the atmosphere; and there is no more beautiful harmony in nature. Animals use the oxygen of the air and give to it carbon dioxide, which soon renders it unfit for respiration; but the green plants take the carbon dioxide, retain the carbon as food and return the oxygen to the air as a waste product. This is as thoroughly established as any fact in plant physiology; and yet, in his experiments, Priestley had some of what he called "bad experiments"; for instead of the plants giving out oxygen and thus purifying the air, they sometimes gave off carbon dioxide, and thus rendered it more impure, after the manner of an animal. What investigator cannot sympathize with Priestley when he calls these "bad experiments"; they appeared so rudely to put discord into his discovered harmony of Nature. But Nature is infinitely greater than man dreams. The "bad experiments" were among the most fruitful in the history of scientific discovery. Ingenhausz (1787) followed them up, carefully observing all the conditions, and found that it was only in daylight that green plants gave out oxygen; in darkness or insufficient light they conducted themselves like animals, taking up oxygen and giving out carbon dioxide. Finally it was proved by Saussure (1804) and others that for green plants, and those without green, like the mushroom, oxygen is as necessary for life as for animals. It thus became evident that this use of oxygen and excretion of carbon dioxide was a property of living matter, and that the very energy that set free the oxygen of the carbon dioxide was derived from oxidations in the green plant comparable with those giving rise to energy in animals. Further that the purification of the air by green plants in light is a separate function—a chlorophyll function, as it has been happily termed by Bernard—and resembles somewhat digestion in animals, the oxygen being discarded as a waste product. Indeed so powerful is the effort made to obtain oxygen for the life processes by some of the lowest plants—the so-called organized ferments—that some of the most useful and some of the most deleterious products are due to their respiratory activity. In alcoholic fermentation, as clearly pointed out by Pasteur and Bernard, the living ferment is removed from all sources of free oxygen, and in the effort for respiration the molecules of the sugar are decomposed or rearranged and a certain amount of oxygen set free.

It has been found that the motile power of some bacteria like *Bacterium termo* depends on the presence of free oxygen in the liquid containing them. When this is absent, they become quiescent. This fact has been utilized by Engelmann and others in the study of the evolution of oxygen by green and other coloured water plants. The bacteria serving as the most delicate imaginable oxygen test, so that when the minutest green plant is illuminated by sufficient daylight, the previously quiescent bacteria move with great vigour and surround it in swarms. Out of the range of the plant, the bacteria are still, or move very slowly, as if to conserve the minute energy-developing substance they have in store until it can be used to the best advantage.

May we not now approach the problem directly, and answer for the whole organic living world the question, "What is respiration?" by saying it is the taking up of oxygen and the giving out of carbon dioxide by living matter? This is the universal and essential fact with all living things, whether they are animals or plants, whether they live in the water or on land. But the ways by which this fundamental life process is made possible, the mechanisms employed to bring the oxygen in contact with the living matter, and to remove the carbon dioxide from it, are almost as varied as the groups of animals, each group seeming to have worked out the problem in accordance with its special needs. It is possible, however, in tracing out these complex and varied methods and mechanisms, to discover two great methods—the Direct and the Indirect.

In the first, there is the direct assumption of oxygen from the surrounding medium, and the excretion of carbon dioxide directly into it. The best examples of this are presented by unicellular forms like the amœba, where the living substance is small in amount, and everywhere laved by the respiratory medium. But as higher and higher forms are destined to appear, evidently the minute, organless amœba could not in itself realize the great aim toward which Nature was moving. There must be an aggregation of amœbas, some of them serving for one purpose and some for another. Like human society, as civilization advances, each individual does fewer things, becomes in some ways less independent, but in a narrow sphere acquires a marvellous proficiency. Or, to use the technical language of science, in order to advance there must be aggregation of mass, differentiation of structure, and specialization of function. Evidently, however, if there is an aggregation of mass, some of the mass is liable to be so far removed from the supply of oxygen, and the space into which carbon dioxide can be eliminated, that it is liable to be starved for the one and poisoned by the other. Nature adopted two simple ways to obviate this—first to form its aggregated masses in the form of a network or sponge, with intervening channels through which a constant stream of fresh water may be made to circulate, so that each individual cell of the mass could take its oxygen and eliminate its carbon dioxide with the same directness as its simple prototype, the amœba.

But in the course of evolution forms appeared with aërial respiration, and the insects, among these, solved the mechanical difficulty of respiration by a most marvellous system of air-tubes, or tracheæ, extending from the free surface, and therefore from the surrounding air, to every organ and tissue. By means of this intricate network, air is carried and supplied almost directly to every particle of living matter. The respiration is not quite direct with the insects, however, for the oxygen and carbon dioxide must pass through the membranous wall of the air-tube before reaching or leaving the living substance.

In the next and final step, the step taken by the highest forms, the living material is massed, giving rise not only to animals of moderate size, but to the huge creatures that swarm in the seas or walk the earth, like the elephant. With all of these the step in the differentiation of the respiratory mechanism consists in the great perfection of lungs or gills, and in the addition of a complicated circulatory system with a respiratory blood, one of the main purposes being, as the name indicates, to subserve in respiration by carrying to each individual cell in the most remote and hidden part of the body the vital air, and in the same journey removing the poisonous carbon dioxide.

This has been called Indirect Respiration, because the living matter of the body does not take its oxygen directly either from air or water, but is supplied by a middleman, so to speak.

The complicated movements by which water is forced over the gills, or by which the lungs are filled and emptied, and the great currents of blood are maintained—that is, the striking and easily observed phenomena of respiration are thus seen to be only superficial and accessory, only serve as agents by which the real and the essential processes, that go on in silence and obscurity, are made possible.

So far I have attempted to give a brief *résumé* of the views on respiration that have been slowly and laboriously evolved by many generations of physiologists, each adding some new fact or correcting some misconception; and I trust that this brief sketch has recalled to your minds the salient facts in our knowledge of respiration, and that it will give a just perspective, and enable me, if I may be permitted, to briefly describe what I believe to be my own contribution to the ever-accumulating knowledge of this subject.

In 1876-77, Prof. Wilder, who may be said to have inherited his interest in the ganoid fishes directly from his friend and teacher, Agassiz, who first recognized and named the group, was investigating the respiration of the forms Amia and Lepidosteus, common in the great lakes and the western rivers. As his assistant it was my privilege to aid in the researches, and to acquire the spirit and methods as in no other way is it so readily possible, by following out, from the beginning to its close, of an investigation carried on by a master. The results of that investigation were reported to this section in 1877, and formed a part of the proceedings for that year. From that time till the present the problems of respiration in the living world have had an ever increasing fascination for me, and no opportunity has been lost to investigate the subject. The interest was greatly increased by the discovery that a reptile—the soft-shelled turtle—did not conform to the generalizations in all the treatises and compendiums of zoology, which state with the greatest definiteness that all reptiles, without exception, are purely air-breathing, and throughout their whole life obtain their oxygen from the air and never from the water. The American soft-shelled turtles, at least, do not conform to this generalization, but on the contrary, naturally and regularly breathe water like a fish, as well as air like an ordinary reptile, bird, or mammal.

In carrying on the investigation of the respiration of the turtle, there appeared for solution the general problem, which, briefly stated, is as follows: In case an animal breathes both air and water, or more accurately, has both an aërial and an aquatic respiration, like the ganoid fishes, Amia and Lepidosteus, like the soft-shelled turtles, the tadpoles, and many other forms, what part of the respiratory process is subserved by the aqueous and what by the aërial part of the respiration? So far as I am aware this problem had not been previously considered. It was apparently assumed that there were in these fortunate animals two independent mechanisms, both doing precisely the same kind of work—that is, each serving to supply the blood with oxygen and to relieve it of carbon dioxide, as though the other was absent. That was a natural inference, for with many forms the respiration is wholly aquatic, all the oxygen employed being taken from the water, and all the carbon dioxide excreted into it. On the other hand, in the exclusively air-breathing animals, as birds and mammals, the respiration is exclusively aërial.

This natural supposition was followed in the first investigations on the respiration of the soft-shelled turtles, and while it was proved with incontestable certainty that they take oxygen from the water like an ordinary fish—that is, have a true aquatic respiration, in addition to their aërial respiration—there was altogether too much carbon dioxide in the water to be accounted for by the oxygen taken from it. Furthermore, upon analyzing the air from the lungs of a turtle that had been submerged some time the oxygen had nearly all disappeared, and but very little carbon dioxide was found in its place, while, as compared with human respiration, for example, a quantity of carbon dioxide nearly as great as that of the oxygen which had disappeared should have been returned to the lungs. Likewise in Professor Wilder's experiments with Amia, to use his own words: "Rather more than one per cent. of carbon dioxide is found in the normal breath of the Amia, but much more of the oxygen has disappeared than can be accounted for by the amount of carbon dioxide." Everything thus appeared anomalous in this mixed respiration, and instead of a clear, consistent, and intelligible understanding of it, there seemed only confusion and ambiguity. Truly these seemed like "bad experiments."

It became perfectly evident that the first step necessary in clearing the obscurity was to separate completely the two respiratory processes, to see exactly the contribution of each mechanism to the total respiration. But this was no easy thing to do. In the first place, the animal must be confined in a somewhat narrow space in order that air and water, which are known to have been affected by its respiration, may be tested to show the changes produced in it by the respiratory process; in the second place, the water has so great a dissolving power upon carbon dioxide that even if it were breathed out into the air it would be liable to be absorbed by the water. Then some means must be devised to prevent the escape of the gases from the water as their tension becomes changed; and, finally, the animal in the water must be able to reach the air. A diaphragm must be devised which would prevent the passage of gases between the air and the water, and at the same time offer no hindrance to the animal in projecting its head above the water. As a liquid diaphragm must be used, it occurred to me that some oil would serve the purpose, but the oil must be of peculiar nature. It must not allow any gases to pass from air to water, or the reverse; it must not be in the least harmful or irritating to the animal under experimentation, and, finally, it must itself add nothing to either air or water. Olive oil was thought of, and later the liquid paraffins. The latter were found practically impervious to oxygen and fulfilled all the other requirements, but unfortunately they absorb a considerable quantity of carbon dioxide. Pure olive oil was finally settled upon as furnishing the nearest approximation to the perfect diaphragm sought.[1]

The composition of the air being known, and a careful determination of the dissolved gases in the water having been made, the animal was introduced into the jar and the water covered with a layer of olive oil from ten to fifteen millimetres thick. The top of the jar was then vaselined, and a piece of plate-glass pressed down upon it, thus sealing it hermetically. Two tubes penetrate this plate-glass cover, one connecting with the overlying air-chamber and the other extending into the water nearly to the bottom of the jar. As the water and air are limited in quantity, the shorter the time in which the animal remained in the jar the more nearly normal would be the respiratory changes, the experiment was continued only so long —one or two hours—as was found necessary to produce sufficient change in the air and the dissolved gases of the water to render the analyses unmistakable.

Proceeding with the method just described, the results given in the following table were obtained:—

Table of Mixed Respiration, showing the number of cubic centimetres of oxygen removed from air and water, and the amount of carbon dioxide added to the air and the water.

	Oxygen		Carbon Dioxide	
	from air	from water	to air	to water
Ganoid Fish (*Amia calva*) . . .	65	10	22	53
Tadpoles (*Larval Batrachia*) .	70	5	24	51
Soft-shelled Turtle (*Amyda mutica*)	31	8	10	29
Bull Frog (*Rana catesbiana*) .	183	4	110	77

NOTE.—The oxygen from both the water and the air, and the carbon dioxide in the air, were determined with exactness in all the experiments; but owing to the failure of some steps in the titration for the carbon dioxide in the water, the figures given for the Amia and the soft-shelled turtle are the calculated results, assuming that the respiratory quotient is one, as that is the relation found by analysis in the other cases.

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[1] See Wm. Thörner on the use of olive oil for the prevention of the absorption of carbon dioxide. Repertorium der analytischen Chemie. 1885, pp. 15-17.

It requires but a glance at the figures in this table to see that the aërial differs markedly from the aquatic part of the respiration. Even in the frog, in which the skin forms the only aquatic respiratory organ, the tendency is marked. The law appears to be unmistakably this, viz. that in combined aquatic and aërial respiration, the aërial part is mainly for the supply of oxygen and the aquatic part largely for the excretion of carbon dioxide. This law, which I stated in 1886, has been confirmed by the repetition of old experiments and by many new ones made during the present summer. It is also confirmed by the experiments made on Lepidosteus in a different way by Dr. E. L. Mark, and published in 1890. I therefore feel that this is the expression of a general law in nature.

From the standpoint of evolution we must suppose that all forms originated from aquatic ancestors, ancestors whose only source of oxygen was that dissolved in the water. As the water is everywhere covered with the limitless supply of oxygen in the air, there being 209 parts of oxygen in 1000 parts of air as contrasted with the 6 parts of oxygen dissolved in 1000 parts of water, it is not difficult to conceive that in the infinite years the animals found by necessity and experience that the needed oxygen was more abundant in the overlying air, and that some at least would try more and more to make use of it. And as any thin membrane with a plentiful blood supply may serve as a respiratory organ to supply the blood with oxygen, it is not impossible to suppose that such a membrane, as in the throat, could modify itself little by little with ever-increasing efficiency; and that a part might become especially folded to form a gill and another might become sacular or lung-like to contain air. While I am no believer in the purely mechanical physiology which sees no need of more than physics and chemistry to render possible and explain all the phenomena of life, yet it is patent to every one that, although vital energy is something above and beyond the energies of physics and chemistry, still it makes use of these; and certainly dead matter forms the material from which living is built. So given a living thing, it, in most cases, moves along lines of least, rather than of greatest, resistance; therefore if practically a limitless supply of oxygen may be obtained from the air and only a limited amount from the water, if anything that might serve as a lung is present, most naturally it (the animal) will take the oxygen from the air where it is in greatest abundance and most easily obtained. On the other hand, carbon dioxide is so soluble in water that practically a limitless amount may be excreted into it; and as it is apparently somewhat easier, other things being equal, for it to pass from the liquid blood to the water than to the air, it seems likewise natural that the gills should serve largely for the excretion of the carbon dioxide into the water. This is the actual condition before us in these, and I believe in all other cases, of mixed or of combined aërial and aquatic respiration. And I believe, as stated above, that it may be laid down as a fundamental law in respiration that wherever both water and air are used with corresponding organs—gills for one and lungs for the other—that the aërial part of the respiration is mainly for the supply of oxygen, and the aquatic part largely for the getting rid of carbon dioxide.

It is not difficult to see in an actual case like that of the Ganoid Fishes (Amia and Lepidosteus) the logical steps in its evolution, by which this most favourable condition has been reached. A condition rendering these fishes capable of living in waters of almost all degrees of purity, and thus giving them a great advantage in the struggle for existence. But what can be said of the soft-shelled turtles, animals belonging to a group in which purely aërial respiration is almost exclusively the rule? Standing alone, this might be exceedingly difficult or impossible of explanation. The Batrachia (frogs, toads, salamanders, &c.) all have gills in their early or larval stage, and most of them develop in the water, and are in the beginning purely aquatic animals. The adults must therefore, in most cases, repair to the water at the spawning season and frequently in laying the eggs they must remain under the water for considerable intervals. Being under the water, and the need of oxygen becoming pressing, there seems to be, by a sort of organic memory, a revival of the knowledge of the way in which respiration was accomplished, when, as larvæ, their natural element was water, and they take water into the mouth and throat. This may be done by as highly a specialized and purely aërial form as the little brown tree-frog (*Hyla pickeringii*) or the yellow spotted salamander (*Amblystoma punctatum*). Another very interesting form, the vermilion-spotted newt (*Diemyctylus*), after two or three years of purely aërial existence goes to the water on reaching maturity and remains there the rest of its life, regularly breathing both by its lungs and by taking water into its mouth and throat. A still more striking example is given by Prof. Cope. The young siren almost entirely loses its gills, and later regains them, becoming again almost completely aquatic in its habits as in the larval stage.

With these examples, which may be seen by any one each recurring year, is it impossible or difficult to conceive that in the struggle for existence the soft-shelled turtles found the scarcity of food, the dangers and hardships on the land greater than those in the water? Or, remaining constantly in the water, and advantageously submerged for most of the time, it gradually reacquired the power of making use of its pharyngeal membrane for obtaining oxygen from the water and excreting carbon dioxide into it as had its remote ancestors. And further, is it not intelligible that with capacious lungs, which it can fill at intervals with air containing so large a supply of oxygen that it, like the other double or mixed breathers, should use its lungs to supply most of the oxygen and its throat to get rid of much of the carbon dioxide?

Indeed it seems to me that if the evolution doctrine is a true expression of the mode of creation, then development may be in any direction that proves advantageous to an organism, even if the development is a reacquirement of long discarded structures and functions.

In closing, may I be permitted to say to the older biologists—to those familiar with the encouragements and inspirations that come with original investigation, that I trust they will pardon what to them is unnecessary personality or excess of detail in this address, for the sake of the younger ones among us, to whom the uphill road of research is less familiar. Judging from my own experience in listening to similar addresses by my honoured predecessors, it is helpful to know, when one is beginning, something of the "dead work," the difficulties and discouragements, as well as the triumphs, in the advancement of science.

MINES AND MINING AT THE CHICAGO EXHIBITION.

THE exhibition of objects relating to mines and mining at the "World's Fair" promises to be one of exceptional interest and importance. The following details about it were given by Mr. George F. Kunz in a paper read before the recent meeting of the American Association for the Advancement of Science:—

The building of mines and mining, which is entirely completed, is 700 feet long and 350 feet wide, at an elevation of 25 feet above the main floor. On both sides is a gallery 60 feet wide, running the entire length of the building. Up to the present time there have applied for space in this building 26 foreign Governments and 36 States, these exhibits to be supplemented by other State and Government exhibits, such as that of Sweden in the Swedish building, the East Indian in the East Indian court, Illinois in their State building, &c.

There will be a scientific collection of all the known elements, and with them a complete collection of all the known alloys of gold, silver, copper, zinc, tin, &c., such as electrum, German silver, Babbits metal, fusible metal, and the thousand and one other, common and rare, used in the arts and industries. In the name of the Lake Superior copper mines, Prof. Alex. Agassiz has promised a complete exposition of ores, rocks, and processes, illustrating the occurrence mining, metallurgy of copper. There is now in preparation a coal collection to contain all varieties of coal, from every known occurrence in the United States. Petroleum will be shown as it never has been at any exhibition. The subject of abrasives of all kinds will form a special exhibit under the charge of Mr. T. Dunkin Paret, who has devoted his entire life to this subject, and is now making a special European trip to enlist the co-operation of foreign manufacturers and investigators to supplement the American exhibit.

The De Beers Mining Company of South Africa, who own and control more than 95 per cent. of the entire diamond output, will make first a full and comprehensive exposition of diamond mining and the original blue stuff, a decomposed peridotite, enclosing carbonaceous shale, the matrix of the diamond, in great quantities. They will show it passing through the various washing machines, and every process separating the diamond from the matrix, in which exists a percentage of 1 carat 205 milligrams in a load of 1600 pounds. There will be a case containing over 10,000 carats of diamonds of all colours and of the various qualities, with a full series of the associated minerals and rocks. Every stage of the cutting and polishing of the diamond will be represented.

Nearly every mineral dealer in the United States has applied for space, and from the foreign trips and other preparations it is very evident that in the line of cabinet specimens and educational minerals the assembled collections will exceed those of any other exposition in importance.

One of the large gallery halls will contain a reference library for the use of visitors. This it is hoped will be a very comprehensive exposition of the literature of the subject of mines, mining, geology, and mineralogy. This is to be supplemented by historical portraits, documents, and other allied material.

An early history of mining and mining processes will be shown, starting with stone hammers and other aboriginal implements found in the copper mines of Lake Superior and the turquoise mines of New Mexico, the old Mexican Pateo, to the most improved modern methods, and the remarkable sectional and glass models of mines, prepared by eminent mining engineers, used in the great mining lawsuits to prove their arguments.

One of the large corridor rooms in the gallery has been offered to the American Institute of Mining Engineers for their own use as a headquarters during the Exposition. They in turn may extend the courtesy to mechanical and civil engineers, as well as the English, German, French, and other foreign engineers whose hospitality they enjoyed in 1889. There is every reason to believe that at least from 800 to 1000 foreign engineers will visit the Exposition.

If only three-fourths of the promised exhibits are received, and there is every assurance that there will be many more coming, it may be safely said, even now, that the mining, metallurgical, geological, and mineralogical exhibits of the Columbian World's Fair will exceed in scientific importance and in extent the combined exhibits of the Centennial, the 1878, 1889, the Paris and the Vienna Expositions, at least two-fold.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Lord Walsingham, the High Steward of the University, has expressed his wish to give annually for three years a gold medal for the best monograph or essay giving evidence of original research in any subject coming under the cognizance of the Special Board for Biology and Geology. The offer having been accepted and the regulations for the medal having been approved, the Special Board for Biology and Geology give notice that the medal is offered for competition for the second time during the ensuing academical year. The essays are to be sent to the chairman of the Special Board (Prof. Newton, Magdalene College) not later than October 1, 1893.

The regulations for the medal are published in the *Cambridge University Reporter*, No. 908 (November 17, 1891), p. 186.

Sir R. S. Ball, Loundean Professor, will give his inaugural lecture in the Anatomical Theatre on Friday, October 21, at noon.

Dr. Cayley, Sadlerian Professor of Mathematics, resigns his place on the Council of the Senate on October 25.

The Council of the Senate recommend that the University of the Cape of Good Hope should be affiliated to Cambridge, on the same terms as those granted to New Zealand.

LONDON.—Four lectures upon "The Sun in its Relation to the Universe of Stars" will be delivered in Gresham College, at six p.m. on the evenings of October 25, 26, 27, and 28, 1892, by the Rev. Edmund Ledger.

SCIENTIFIC SERIALS.

The Journal of the Royal Agricultural Society of England, 3rd Series, Vol. iii., pt. 3.—Allotments and Small Holdings, by Sir J. B. Lawes and Dr. Gilbert. The authors have collected statistics relating to Allotments and Small Holdings in Great Britain. They point out that "within the present century there has been a great reduction in the number both of owners and of occupiers of farms not exceeding 50 acres in area, such as it seems to be the object of the promoters of the Small Holdings Act of 1892 greatly to increase." After noticing the Rothamstead Allotments they proceed to discuss the conditions essential to the success of small holdings, and they conclude that ordinary rotation farming is much less suitable for small holdings than dairy farming, the production of poultry and eggs, and market gardening when favourable conditions exist; the authors do not believe, however, that the system of small holdings will materially check the influx of agricultural labourers into the towns. This number of the *Journal* also contains a short article by W. H. Hall on Small Holdings in France. Mr. Hall is "convinced that small holders (in England) have a great future before them as soon as they can be educated up to producing such articles as require to be consumed fresh, and will not bear long carriage." This last clause contains the key of the whole matter.—On the Vermin of the Farm, pt. ii., by J. E. Harting. In this paper the author has much to say in defence of the mole (*talpa europæa*), and of the weasel (*mustela vulgaris*); there is little but condemnation, however, for the hedgehog, the stoat, and the polecat; the last-mentioned animal is now hardly known to most people, though the domesticated variety (the ferret) is common.—The Warwick Meeting of 1892, by Dr. Fream, Official Reporter. This report shows the meeting to have been a good average one, except in the attendance of visitors on the last two days. Judge's reports show that in many cases the quality of the exhibits of live stock was far above the average.—Miscellaneous Implements Exhibited at Warwick, by T. H. Thursfield.—The Farm Prize Competition of 1892, by J. B. Ellis.—Among the shorter articles is one deserving of careful attention, entitled New Modes of Disposing of Fruit and Vegetables, by Chas. Whitehead, in which are discussed the "evaporating" and the "canning" of fruit; methods already in use in Queensland are described and discussed with reference to their adoption in this country when prices for fresh fruit are low.—Dr. J. W. Leather contributes a short article upon his method of detecting and estimating "castor-oil seeds in cattle foods." A weighed quantity of the suspected food is digested with hot dilute sulphuric acid (or HCl, about 2 p.c.) for half an hour, washed free from acid, re-digested with a hot dilute solution of caustic soda, washed, and then finally treated with a quantity of bleaching powder. The husks of all seeds other than castor-oil seeds are bleached by this treatment, and any unbleached husks can be picked out and weighed.

Wiedeman's Annalen der Physik und Chemie, No. 9.—The principle of least effect in electrodynamics, by H. von Helmholtz.—On the differences of potential of chains with dry solid electrolytes, by W. Negbaur.—On the reciprocity of electric osmose and flow currents, by U. Saxén.—Resonance phenomena and absorptive capacities of metals for the energy of electric waves, by V. Bjerknes.—Objective presentation of the Hertzian experiments with rays of electric force, by L. Zehnder.—Dispersion and absorption of light according to the electrical theory of light, by D. A. Goldhammer.—On the measurement of high temperatures, by L. Holborn and W. Wien. The apparatus was a modification of Le Chatelier's thermo-element, consisting of a combination of platinum and a platinum-rhodium alloy. This was calibrated by placing it inside the porcelain vessel of an air-thermometer and compairing the readings, different thermo-couples were compared by exposing together in short porcelain tubes, two branches being welded together. The following fusing temperatures were deduced: gold 1072°, silver 968°, copper 1082°.—On the expansion of gases at low pressures, by G. Melander. Working with pressures ranging from 770 to 4mm, and temperatures from 0° to 100°, the gases being kept at constant volume, the supposed law of constant decrease of coefficient of expansion with decreasing pressure was found not to hold good. That of air decreases down to 232mm, where it is 0·003659, and then increases. That of carbon dioxide decreases down to 76mm, after which it increases, whilst that of hydrogen increases steadily.—Specific gravity and heat of fusion of ice, by J. v. Zakrzevski. The apparatus was a very delicate form of Bunsen's ice calorimeter. The specific gravity of ice at −0·701° C. was found to be 0·916710. The cubical coefficient of expansion at that temperature was 0·000077, which gives for the sp. gr. of ice at 0° C the value 0·916660.—On the theoretical conceptions of Georg Simon Ohm, by K. Von der Mühll.—Variation of the specific volume of sulphur with the temperature, by M. Toepler.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 16.—"Thermal Radiation in Absolute Measure." By Dr. J. T. Bottomley, M.A., F.R.S.

The paper contains an account of an experimental investigation by the author in continuation of researches on the same subject which have been already published (Roy. Soc. Proc., 1884, and Phil. Trans., 1887). In the earlier experiments metallic wires heated by an electric current were used. The loss of heat from a heated body, however, depends to some extent on the form and dimensions of the body; and it seemed important to experiment on the loss of heat from bodies differing in form from the wires already used, and larger in dimensions.

Accordingly, two copper globes used by Mr. D. Macfarlane in 1872 (Roy. Soc. Proc., 1872, p. 93) were employed for a new series of experiments.

After preliminary experiments (using the same enclosure which Macfarlane employed and with the surfaces of Macfarlane's globes prepared in four different ways) new apparatus was constructed. The object was to experiment both with full air pressure and with different amounts of exhaustion of the air, and Macfarlane's enclosure is unsuitable for this purpose.

In the arrangement adopted, the heated globes were hung at the centre of a hollow metallic sphere, which was connected with the Sprengel pump and surrounded with cold water, and were allowed to cool. The temperature of the cooling globe was read off at equal intervals of time by means of a thermo-electric junction; and from these readings the absolute loss of heat per unit of cooling surface, per unit difference of temperatures of surface and surroundings, per unit of time, is calculated.

The details of the apparatus and method of experimenting are given in the paper. It is enough to say here that the globes were used with their surfaces in two different conditions:—(1) Thinly coated with lamp-black, and (2) silvered and brightly polished; and in both conditions the absolute loss of heat, both in air and in vacuum more or less complete, was determined. The tables and curves attached to the paper give the details of the results.

To quote one or two examples:—With the sooted surface a total loss of heat by convection and radiation of $3{\cdot}42 \times 10^{-4}$ c.g.s. units per square centimetre, per second, per 1° C. of difference of temperatures of globe and surroundings, was observed with a difference of temperatures of 100° C., and with the surroundings at about 14° C. Under similar circumstances the radiation in vacuum of $\frac{1}{2}$M (half-a-millionth of atmospheric pressure of non-collapsible gas) was about $1{\cdot}40 \times 10^{-4}$.

Taking a silvered and brightly-polished surface under the same circumstances, the loss in full air was $2{\cdot}30 \times 10^{-4}$ c.g.s.; and with the highest vacuum and brightest polish obtained, it was reduced $1{\cdot}80 \times 10^{-5}$, with in this case a difference of temperatures of 180° C. The loss with 100° C. difference would be considerably less, but is not known experimentally at present.

The author returns thanks to Mr. James H. Gray, M.A., B.Sc., for excellent assistance given; and expresses himself most deeply indebted, both for assistance in experimenting and calculating of the results, and for most valuable and ingenious aid of various kinds during the course of this work, to his friend Mr. A. Tanakadate, now Professor in Tokio, Japan.

Entomological Society, October 5. Henry John Elwes, vice-president, in the chair.—Mr. C. O. Waterhouse exhibited a specimen of *Latridius nodifer* feeding on a fungus, *Trichosporium roseum*.—Mr. McLachlan, F.R.S., exhibited a male specimen of *Elenchus tenuicornis*, Kirby, taken by the Rev. A. E. Eaton, on August 22 last, at Stoney Stoke, near Shepton Montague, Somerset, and described by him in the *Entomologist's Monthly Magazine*, October 1892, pp. 250-253. Mr. McLachlan stated that another specimen of this species had been caught about the same date in Claygate Lane, near Surbiton, by Mr. Edward Saunders, who discovered that it was parasitic on a homopterous insect of the genus *Liburnia*, and had also described it in the *Entomologist's Monthly Magazine*.—Mr. J. M. Adye exhibited, for Mr. McRae, a large collection of *Colias edusa*, *C. edusa* var. *helice*, and *C. hyale*, all taken in the course of five days' collecting in the neighbourhood of Bournemouth and Christchurch, Hants. There were twenty-six specimens of *helice*, some of which were remarkable both in size and colour. He stated that Mr. McRae estimated the proportion of the variety *helice* to the type of the females as one in fifty. Mr. Adye also exhibited two specimens of *Deiopeia pulchella*, recently taken near Christchurch. Mr. Hanbury, Mr. Jenner-Weir, and Mr. Merrifield commented on the interesting nature of the exhibition, and on the recent extraordinary abundance of *C. edusa* and the var. *helice*, which was probably not exceeded in 1877.—Mr. Dallas-Beeching exhibited four specimens of *Plusia moneta*, lately taken in the neighbourhood of Tunbridge Wells.—Mr. H. Goss exhibited, for Mr. Gervase F. Mathew, two *Plusia moneta* and their cocoons, which were found at Frinsted, Kent, on September 3 last. It was stated that Mr. Mathew had found seven cocoons on the under side of the leaves of monkshood, but that the imagos had emerged from five of them.—Mr. Rye exhibited a specimen of *Zygæna filipendulæ* var. *chrysanthemi*, and two varieties of *Arctia villica*, taken at Lancing, Sussex; also varieties of *Coccinella ocellata* and *C. oblougoguttata* from Oxshott.—Mr. A. H. Jones exhibited specimens of *Argynnis pales* var. *isis*, and var. *arsilache*, the females of which showed a tendency to melanism, recently taken in the Upper Engadine; also melanic forms of *Erebia melampus*, and a specimen of *Erebia nerine*.—Mr. Elwes exhibited specimens of typical *Erebia melas*, taken by himself in the Western Tyrol, on July 25 last, at an elevation of 7000 feet: also specimens of the same species from Hungary, Greece, and the Eastern and Central Pyrenees. He stated that the absence of this species from the Alps, which had seemed to be such a curious fact in geographical distribution, had been first disproved by Mrs. Nicholl, who discovered it at Campiglio two years ago. He also exhibited fresh specimens of *Erebia nerine*, taken at Riva, on the lake of Garda, at an elevation of about 500 feet; also specimens of the same species, taken at the same time, at an elevation of about 5000 feet, in cool forest glades; and remarked that the great difference of elevation and climate did not appear to have produced any appreciable variation in this species.—Mr. G. T. Porritt exhibited two varieties of *Abraxas grossulariata*, bred during the past summer from York larvæ. Also a curious Noctua taken on the sandhills at St. Anne's-on-Sea on August 20 last, and concerning which a difference of opinion existed as to whether it was a melanic form of *Agrotis cursoria* or of *Caradrina cubicularis*. Also a small dark form of *Orgyia antiqua*, which had occurred in some numbers at Longridge, near Preston.—Mr. A. Eland-Shaw exhibited a specimen of *Mecostethus grossus*, Linn., taken lately at Irstead, in the Norfolk-broad district. He stated that this was the first recorded capture of this species in Britain since 1884.—Mr. C. G. Barrett exhibited a specimen of *Syricthus alveus*, caught in Norfolk about the year 1860; a beautiful variety of *Argynnis euphrosyne*, caught this year near Godalming; and a series of varieties of *Ennomos angularia*, bred from a female taken at Nunhead.—Mr. P. Crowley exhibited a specimen of *Zygæna filipendulæ* var. *chrysanthemi*, taken last August at Riddlesdown, near Croydon.—Lord Walsingham, F.R.S., sent for exhibition several specimens of larvæ of *Sphinx pinastri*, preserved by himself, which were intended for presentation to the British Museum. The larvæ had been sent to him by Lord Rendlesham, who obtained them from ova laid by a female captured in Suffolk last August.—M. de Nicéville communicated a paper entitled "On the variation of some Indian Euplœas of the subgenus *Stictoplœa*"; and Captain E. Y. Watson exhibited, on behalf of M. de Nicéville, the specimens referred to in this paper. Colonel Swinhoe, Mr. Hampson, Mr. E. B. Poulton, F.R.S., and the chairman took part in the discussion which ensued.—Mr. W. Bateson read a paper entitled "On the Variation in the Colours of Cocoons and Pupæ of Lepidoptera; further Experiments."—Mr. Poulton read a paper entitled "Further Experiments upon the Colour-relation between certain Lepidoptera and their Surroundings."—Miss Lilian J. Gould read a paper entitled "Experiments on the Colour-relation between certain Lepidopterous larvæ and their surroundings, together with observations on Lepidopterous larvæ." A long discussion ensued, in which Mr. Jenner Weir, Dr. Sharp, F.R.S., Mr. Merrifield, Mr. Poulton, and the chairman took part.

PARIS.

Academy of Sciences, October 10. M. Duchartre in the chair. M. Emile Picard presented to the Academy the second volume of his "Traité d'analyse."—The University of Padua invited representatives of the Academy at the forthcoming tercentenary celebration of Galileo's accession to his chair at that University.—A decisive blow to the theory of centripetal and ascending motion in cyclones, by M. H. Faye.—The movements of the heart, studied by chronophotography, by M. Marey. The heart of a tortoise was removed and mounted so that a funnel led into an auricle, and a bent tube out of the ventricle and upwards to the mouth of the funnel. The funnel was filled with defibrinated blood, which passed into the auricle and thence into the ventricle. When the latter was full, an automatic systole projected the blood upwards through the tube and back into the funnel. This process was repeated for several hours after death. It was more minutely studied by taking a series of instantaneous photographs in rapid succession (reproduced), which show the details of the process with great accuracy. For actinic purposes, the heart was painted white with water-colour. The hypothesis of an active diastole of the ventricle was proved to be unfounded.—The inhibitory phenomena of the nervous shock, by M. H. Roger.—On the transformation of the equations of Lagrange, by M. Paul Painlevé.—On a class of curves and surfaces, by M. A. Pellet. On the motion of a thread in space, by M. G. Floquet.—On internal reflection in crystals, by M. Bernard Brunhes.—A new method of preparation and photometry of the phosphorescent sulphide of zinc, by M. Charles Henry. It is possible to obtain several pounds at a time of a fine phosphorescent zinc sulphide by the following process: Add ammonia to a perfectly neutral solution of pure zinc chloride; redissolve the precipitate in an excess of ammonia; precipitate completely, but without the slightest excess, the ammoniacal oxide of zinc by sulphuretted hydrogen; heat to a white heat in a crucible of refractory earth placed inside a graphite crucible, after having well washed and dried the amorphous sulphide to the exclusion of all impurities. By Mascart's photometer, the intensity of light emitted by a sample of the sulphide in candle-metres after saturation was 0·000215. But this value is probably too small.—On the antimonites of pyrogallol, by MM. H. Causse and C. Bayard.—On the tartaric ethers, by M. P. Freundler.—Volumetric determination of the alkaloids, by M. L. Barthe.—On a new method of brick manufacture, used in certain parts of Central Asia, by M. Edouard Blanc. This mode of manufacture is practised by the tribes in Western Mongolia, on the frontier of Siberia. The extremes of temperature render a brick of great durability a necessity of life. This is attained by the use of steam. The oven is cylindrical and surmounted by a hemispherical cap, which is kept open for the first three days. The bricks, about 7000 at a time, are baked by means of a fire fed by about 7000 kgr. of an annual ligneous plant, the *Alhagi Camelorum*. On the third day, the opening is closed with felt, which is kept constantly wetted, so that the bricks are enclosed in a steam bath, while kept at a red heat. Under these circumstances, some novel chemical reactions appear to take place. The bricks, red after the first period, appear dark grey after the second part of the process. Their structure appears porous; they become sonorous and acquire a great hardness. They show a striking resemblance to certain trachytes. Made from the same clay as our bricks, they resist weathering very much better, and have an extraordinary hardness and cohesion.—A process for testing the purity of coprah oils and palm oils, by M. Ernest Milliau.—On the part played by spermine in intra-organic oxidations, by M. Alexandre Poehl.—On the respiration, transpiration, and dry weight of leaves developed in sunlight and in the shade, by M. L. Geneau de Lamarlière.—On the structure of the assimilating tissue of the branches in Mediterranean plants, by M. William Russell.—Experimental study of the action of the humidity of the soil on the structure of branches and leaves, by M. Auguste Oger.—Contributions to the stratigraphy of the Pyrenees, by MM. Roussel and De Grossouvre.—On some bombs of Etna, from the eruptions of 1886 and 1892, by MM. L. Duparc and L. Mrazec.—Meteoric iron recently fallen at Hassi Iekna, in Algiers, by M. Stanislas Meunier.—Oceanographic observations relating to the basin of Arcachon (Gironde), by M. J. Thoulet.—Vegetation of the lakes of the Jura mountains, by M. G. Rambault Ant. Magnin.—M. Bischoffsheim, on behalf of Prof. Weineck, Director of the Prague Observatory, presented a photograph of the lunar crater Vendelinus.

DIARY OF SOCIETIES.

LONDON.

SUNDAY, OCTOBER 23.

SUNDAY LECTURE SOCIETY, at 4.—The Distribution of Animals and what it Teaches (with Oxy-hydrogen Lantern Illustrations): Dr. Andrew Wilson.

TUESDAY, OCTOBER 25.

MINERALOGICAL SOCIETY.—Anniversary Meeting.—Council Report.—On Crystallized Zirconia (Baddeleyite), a New Mineral Species from Ceylon: L. Fletcher, F.R.S.—Preliminary Note on Xanthoconite and Rittingerite: H. A. Miers and G. T. Prior.—A Locality of Cerium Minerals in Cornwall; H. A. Miers.—On Gypsum from Herne Bay: F. Rutley.

FRIDAY, OCTOBER 28.

PHYSICAL SOCIETY, at 5. Discussion of Mr. Williams's Paper on the Dimensions of Physical Quantities.—Dicussion of Mr. Sutherland's Paper on the Laws of Molecular Force, to include Papers by Dr. Young and Mr. Thomas on the Determination of Critical Density, Critical Volume, and Boiling Points.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Framework of Chemistry, Part 1; W. M. Williams (Bell).—A German Science Reader; F. Jones (Percival).—Chemical Lecture Experiments: G. S. Newth (Longmans).—Outlines of Psychology, new edition: Dr. J. Sully (Longmans).—Animals' Rights: H. S. Salt (Bell).—University College of North Wales Calendar for the Year 1892–93 (Manchester, Cornish).—The Climate of Rome and the Roman Malaria: Prof. Tommasi-Crudeli, translated (Churchill).—The Fauna of Liverpool Bay, Report 3 (Liverpool, Dobb).—Atomic Consciousness (Whimple, Harris).—Geographische und Naturwissenschaftliche Abhandlungen, I.: Dr. J. Rein (Leipzig, Engelmann).—Metal-Colouring and Bronzing: A. H. Hiorns (Macmillan).—The Telephotographic Lens: T. R. Dallmeyer (Dallmeyer).—The Geological and Natural History Survey of Minnesota: N. H. Winchell (Minnesota).—Brachiopoden der Alpinen Trias, Nachtrag I.: A. Bittner (Wien).—Atlas der Völkerkunde: Dr. G. Gerland (Gotha, J. Perthes).—British Fungus Flora, vol. i.: G. Massee (Bell).

PAMPHLETS.—Rutherfurd Photographic Measures of the Stars about β Cygni: H. Jacoby (New York).—Ueber die Einseitigkeit der Herrschenden Krafttheorie: Dr. N. von Seeland (Leipzig, Pfeffer).—Weitere Untersuchungen über die Tägliche Oscillation des Barometers: J. Hann (Wien).

SERIALS.—Internationales Archiv für Ethnographie, Band 5, Heft 4 (Kegan Paul).—Annals of Scottish Natural History, October (Edinburgh, Douglas).—Palestine Exploration Fund Quarterly Statement, October (Watt).—Transactions of the Leeds Naturalists' Club, &c., 1890, vol. 2 (Leeds).—Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 1891-92, vol. 5, No. 2 (Manchester).—Notes from the Leyden Museum, vol. xiv. Nos. 1 and 2 (Leyden, Brill).—Morphologisches Jahrbuch, 18 Band, 4 Heft (Williams and Norgate).—Botanische Jahrbucher für Systematik, Pflanzengeschichte und Pflanzengeographie Sechzehnter Band, 2 Heft; Fünfzehnter Band, 4 Heft (Williams and Norgate).—Journal of the Royal Statistical Society, September (Stanford).—Mind, October (Williams and Norgate).—The Asclepiad, No. 35, vol. 9 (Longmans).—Medical Magazine, October (Southwood).—Jahrbuch der k.k. geologischen Reichsanstalt, Jahrg. 1892, xlii. Band, 1 Heft (Wien).—Bulletin of the New York Mathematical Society, vol. 2, No. 1 (New York).

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THURSDAY, OCTOBER 27, 1892.

POLAND'S "FUR-BEARING ANIMALS."

Fur-bearing Animals in Nature and Commerce. By Henry Poland, F.Z.S., 1 vol., 8vo. (London: Gurney and Jackson, 1892.)

ALTHOUGH, as civilization spreads with ever-quickening progress over all parts of the world's surface, wild animals necessarily diminish in numbers year by year, few people have any idea of the enormous quantities of furs and pelts still annually imported into the United Kingdom, and of the extent of the commerce in such commodities still carried on. Mr. Poland's useful treatise on Fur-bearing Animals will afford us much information on this subject. In the introduction to his volume full statistics about the past and present condition of the fur-trade are given, and it is stated that at the great fur-sales now held at the College Hill sale-rooms in London the annual value of all classes of fur-skins sold is little short of £1,000,000.

But it is with the main portion of the present work that naturalists will be most interested, as, so far as we know, this is the first occasion on which a large amount of practical knowledge of the subject has been combined with a certain amount of scientific information. Mr. Poland takes the fur-bearing animals systematically, mostly, it appears, according to the order and nomenclature employed in the list of animals in the Zoological Society's Gardens, and gives us under each head particulars as to their localities, distribution, coloration, and varieties, together with information as to the quantities of skins imported and the uses to which they are devoted.

Beginning with the Quadrumana, we find that the skins of about twenty-five Monkeys and Lemurs are used in commerce. Of these the most abundant is the "Black Monkey" of Western Africa (*Colobus vellerosus* and other allied species), of which some 90,000 are imported every year. Another species of Colobus, the Guereza of Abyssinia and Eastern Africa, also furnishes a "rare and much esteemed skin," of which the value is from 10*s.* to 15*s.* We may remark that the Tcheli Monkey (*Macacus tcheliensis*) is not from Cochin China, as stated by Mr. Poland, but from Mantchuria, north of Pekin, where it ranges further north than any other Monkey now existing. There is a fine example of this species at present living in the Zoological Society's Gardens. The "China Grey Monkey," described as having a "long white tail," is evidently of quite a different species, the Tcheli Monkey having only a very short caudal appendage.

The Carnivora, which next follow, take up the greater part of Mr. Poland's volume, nearly 150 species of this extensive group supplying pelts which are more or less useful to mankind. Commencing with the larger Cats, our author calls attention to the great difference between the Bengal Tiger and the Mongolian or Chinese variety of the same animal, in which the fur is very thick, often from 1½ to 2 inches in length, and makes a long fringe round the face. Skins of the Chinese Tiger are much esteemed on this account, and fetch from £10 to £40 each, according to quality; whereas a good Bengal Tiger skin may be purchased at about £4 or £5. The Lynx is another of the true Cat-tribe which furnishes a rather important article of trade, the quantity of Lynx-skins imported by the Hudson's Bay Company ranging up to 40,000, and in exceptional years reaching even to 70,000. Coming to the Musteline Carnivora or Weasels, we find the Mink (*Mustela vison*) an animal of still greater importance in trade. In 1890 upwards of 360,000 skins of the Mink from North America were sold in London, and converted mostly into muffs. On the other hand, an allied species of the same genus, the Ermine (*M. erminea*), formeriy so much esteemed, and regarded as a princely fur to be devoted exclusively to royalty, is going quite out of fashion. "It has become very much neglected. and a few years ago was practically unsaleable."

The fur of the Skunk, *Mephitis mephitica*, many persons will be surprised to hear, in spite of its "powerful scent," which "cannot be entirely got rid of," is largely used. In 1891 nearly 700,000 skins of it were imported, and worked up into muffs and capes. But the prince of furs of this division of the Carnivora is that of the Sea-otter, *Enhydra lutris*, of the north-west coast of America, an animal generally supposed to be almost extinct in consequence of long ages of persecution. But 2369 Sea-otter skins were imported by the Alaska Commercial Company and other traders in 1891, and sold at an average price of £57 apiece. "The fur is principally consumed in Russia, where it is used for collars of noblemen's coats."

From the Sea-otter we pass by an easy transition to the Fur-seals—a group still of sufficient importance to have brought three of the greatest nations of the world nearly to loggerheads, but in bygone years much more abundant than now. From South Georgia in the Antarctic Seas one million two hundred thousand Fur-seal-skins are said to have been taken soon after its discovery, and nearly an equal quantity from Kerguelen Island, but the natural consequence has followed that the animal has become practically extinct in the Antarctic seas. The only species of Otaria that still yields its skin year by year to supply the ladies of Europe and America with "sealskin jackets" is the Alaska Fur-seal, *Otaria ursina*, which, owing to the stringent regulations enforced for its preservation, is still abundant in certain parts of the North Pacific. According to the best authorities about 4,500,000 of this Fur-seal resort to the Pribylov Islands every breeding season, and until 1890, when the number to be slaughtered was reduced, 100,000 were killed every year. Smaller quantities are obtained from other parts of the North Pacific. We need not here go into further details upon this animal which has lately been the subject of so much discussion, except to say that unless even more severe regulations are made for its preservation than those now existing, the Alaska Fur-seal will indubitably share the fate of its Antarctic brethren, and cease to furnish an article of commerce.

Of the order Insectivora, which follows the Carnivora, Mr. Poland only mentions two species as supplying fur for the use of mankind. These are the Common Mole (*Talpa europæa*) and the Russian Musk-rat or Desman (*Myogale moschata*). The skin of the Mole is so small as to be of little value, but several thousands are collected annually and converted into those most comfortable of garments, moleskin waistcoats. The fur of the

Russian Desman (*Myogale moschata*) is sometimes used in this country for mantle-trimmings, but is more appreciated in America. The Desman of the Pyrenees (*M. pyrenaica*), which Mr. Poland confounds with that of Russia, is a much smaller and quite different animal.

We now come to the great group of Rodents, many of which supply their skins in enormous quantities for the benefit of mankind. Mr. Poland's list contains thirty-three species of this Order. The Beaver, formerly of such pre-eminent importance, is now much reduced in numbers, but 63,419 Beaver-skins were sold by the Hudson's Bay Company in 1891. Another Canadian Rodent, the Musquash (*Fiber zibethicus*), still ranges over the "north-west" in enormous armies, from three to four millions of their skins being obtained every year. In 1891 the Hudson's Bay Company alone sold 554,104 of them. Another much appreciated little animal of the Rodent order is the Chinchilla from the highlands of Chili and Bolivia. Its fur, which is remarkably soft and delicate, is principally used in England, France, and America. Several allied species of the peculiar South American family *Chinchillidæ* are also called by the general name of "Chinchilla."

Of the Leporidæ or Hare-family, which concludes the Rodents, the Polar Hare and the Common Rabbit supply the largest numbers of useful skins. Of the Russian or Polar Hare (*Lepus glacialis*)—one of the best-known denizens of Arctic latitudes—from 2,000,000 to 5,000,000 skins are said to be collected annually, mostly in their thick white winter coats. But Rabbit-skins are employed in much more enormous quantities. Since the great increase of this Rodent in Australia and New Zealand, where, as is well known, the Rabbit has become an awful pest, the number of its skins sent to London for sale from those colonies has increased year by year, until, according to Mr. Poland's calculations, from fifteen to twenty millions are now imported. Very large numbers of Rabbit skins are also brought to England from France, Germany, and other countries, mostly taken from domestic varieties.

The American "Buffalo" (more correctly "Bison") is extinct as regards trade purposes, so that we need not go into the quantities of "Buffalo-robes" formerly imported, which in Catlin's time reached 200,000 in the year; nor will the other species of the order Ungulata, of which Mr. Poland gives forty-six in his list as affording skins more or less used in commerce, detain us long. The most important of them are the different varieties of the domestic Sheep and Goat, which are spread all over the world and supply mankind with every variety of clothing-materials. The extent of this commerce is enormous. Of tanned Goatskins alone 7,259,212 were imported into this country in 1891, and 5,613,996 skins of "East Indian Sheep" were sold in London.

The Edentates, Marsupials, and Monotremes, with which Mr. Poland concludes his volume, are of small importance after the preceding orders. "Australian Opossum," however, under which common name are included skins of several different species and varieties of the genus *Phalangista*, forms an exception, as the annual supply of this article exceeds two million skins, which are much appreciated for their "cheapness, light weight, pretty colour, and general usefulness." Of Kangaroos of all sorts over 120,000 skins were imported in 1891, so that, what with these and the Phalangers and its twenty million Rabbit-skins, Australia has a fair share of this lucrative commerce. But altogether, no doubt, the Dominion of Canada and adjoining district of Alaska still get the lion's share of the traffic in "furs and pelts."

In concluding our somewhat lengthy notice of Mr. Poland's volume we may say that it is replete with information that a zoologist cannot obtain elsewhere in a convenient form, but at the same time contains many errors in the identification of the species, some of which we have pointed out. In a second edition, which will doubtless be called for, the author should obtain the assistance of a scientific expert. He would also do well to cut out of his list some of the less important species (such as the Dingo, Great Anteater, and Echidna), which are not really used for trade-purposes, and to bring up his statistical information under every head to the most recent date.

SPINAL NERVE—IMPULSES AND ELECTROMOTIVE CHANGES.

The Structure and Functions of the Brain and Spinal Cord. By Victor Horsley, B.S., F.R.C.S., F.R.S. (Griffin and Co., 1892.)

As stated in the preface, the present volume (being the Fullerian Lectures for 1891) discusses the spinal cord and ganglia alone, and is to be followed by two others, dealing respectively with the brain and with physiological psychology.

Most books of this character have to be considered in their relation to two classes of readers—those who are experts in its subject-matter and those who are not—a distinction that applies with special force to the outcome of Royal Institution lectures. We shall therefore take two readings of the volume before us.

The table of contents and a cursory glance at the text very soon bear out the author's modest remark that these lectures have no pretensions to form a monograph upon the subject of which they treat. Nor are they an elementary review of it (in the ordinary sense of these words), but rather a series of vignettes—historical, zoological, and speculative—relating to the nervous system. The historical lecture is interesting; the curious and hideous figure on p. 13, from a twelfth-century manuscript in the Bodleian Library, very aptly fulfils its purpose, viz., to demonstrate that no advance is there apparent upon the ideas of Aristotle. Prof. Horsley avoids plainly asserting that Sir Charles Bell discovered the sensory and motor functions of the nerve-roots; the statement is implied, not made; at first reading we think it is made, on second reading we recognize that it is not made, on third reading that it is positively implied. It is evident that Prof. Horsley has read Bell's original pamphlet, "Idea of a New Anatomy of the Brain" (1811);[1] he does not, however, go on to say that Bell's two roots (before 1824) were an anterior "cerebral" root, subserving motion and sensation, and a posterior "cerebellar" root serving to govern vital actions. The *principle* of localization in nerve-roots, far more clearly stated by Walker in 1809 and the facts demonstrated by Majendie in 1822, are not alluded to. In the second lecture Kleinenberg's cells are figured and described, and on the next page admitted to be mythical; thus Prof. Horsley is enabled legitimately enough to utilize this time-honoured if anatomically incorrect illustration to enforce the essentially correct principle of differentiation. Lecture III. treats of jelly-fish, star-fish, and cray-fish, with reference to rhythm, "localization" and co-ordination of movements. "Localization" is used as a term to denote a physiological property or function (pp. 48–49); *i.e.*, as used by psychologists to denote an act of the subject, rather than as used by physiologists to indicate observed relations between parts and functions. This use of the word is perfectly legitimate, but it is rather apt to create confusion of thought. "Localization" is sometimes used in a similar sense in relation to brain-function, and with a similar inconvenience; "localization" *by* the brain in a psychological sense is properly localization by the subject, localization *in* the brain is an object of physiological experiment. No doubt it may be said that psychological localization rests upon physiological differentiation and localization; none the less the use of the term to denote a physiological property or function is not advisable without very careful definition. Lecture IV. deals with vertebrates—nerve-fibres, gullet theory of canalis centralis, spinal cord, and nerve-roots. Lecture V. with ganglia. Here we must criticise. Looking to the class of readers addressed, Fig. 26 may be misleading as regards the anatomy of anterior and posterior roots. Fig. 28 (altered from Hirschfeld and Leveillé) is very confusing, and the anatomy of the brachial and lumbar plexuses is strange. A reader who should gather his notions of the functions of spinal ganglia from pp. 110–113 would have a very wrong idea of the state of our physiological knowledge; nor does the odd expression, "the immense discovery by Claude Bernard, of the so-called vaso-motor system of nerves," possess much justification as regards historical accuracy.[1]

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[1] Not an easy matter—we only know of one copy in London, that at the British Museum, misdated 1802—nor a superfluous matter, as any one knows who has compared the "reprints" of 1824 and of 1830 with the original paper in the Phil. Trans. of 1821 on the nerves of the face. Correct reprints of Bell's first paper have been published in "Documents and Dates of Modern Discoveries in the Nervous System," (? by A. Walker). London, 1839, and in the "Journal of Anatomy and Physiology" for 1869, by A. Shaw.

The four last lectures contain—necessarily mingled with familiar elementary considerations—a statement of the results arrived at by Professors Gotch and Horsley from their electrical investigation of nerve-impulses in afferent and efferent nerve-channels, and to the expert form the most important part of the book. We begin, therefore, to read more closely, still bearing in mind, as indeed is suggested by the style, the requirements of non-expert readers. Nothing arrests attention on the first two pages. On p. 129 we pause at this sentence:—"It is very interesting to see that the protoplasm of a nerve-conductor has a distinctly longitudinal arrangement, which, it is not going too far to suggest may, by virtue of this fact, be more adapted for the polarization of its molecules for the better transmission of nerve-impulses." Having dissected out the possible meaning of this sentence we proceed. Two pages further we are stopped for a moment by a confusion between the local excitability of nerve and its conductivity. On the next page (p. 132) we demur to the assertion that "secondary tentanus depends upon the electrotonic state of the first preparation." On page 138 we find no reason to accept the distinction that "no doubt may reasonably exist that active nerve yields products of oxidation, which doubt certainly exists as to the acidification of nerve." Both facts are possible but unproven; no proof whatever has been attempted of the first; the second has been investigated with positive and with negative results. Page 146 includes a figure in which the current is *not* shown as an action current, but the reverse; moreover, with the instrument figured (capillary electrometer), *no current* is under observation.

But these twenty pages are enough, and we shall have but little space to discuss what forms the main positive differentia between Prof. Horsley's book and other books of the same class, *i.e.*, the conclusions derived from electrical data.

The conditions of criticism in this connection are altogether different, and we need not stop to examine into the accuracy of elementary points. Prof. Horsley is now addressing himself to an expert audience; his reasoning and his data have yet to pass through the refining fires of doubt and of objection, with, it is to be hoped, ultimate confirmation. The principle of the method of investigation is a well-established one; we know that electrical variations are indicators of functional variations; in the spinal cord, as elsewhere, functional activity may therefore be roughly gauged by galvanometer or by electrometer. Gotch and Horsley did this as regards efferent channels and afferent channels; as regards the first they found by the electrometer that the character of discharge in the pyramidal tract does not differ from its character in motor nerves; as regards the afferent tract they find that impulses pass up the cord chiefly in the posterior column of the same side. These conclusions may be admitted without imprudence. But the conclusions that may not safely be admitted without further experimental elaboration, are those relating to the functional discharges (inferred from electrical discharges) up and down the anterior and posterior roots, and to the quantitative distribution of centripetal impulses in the various columns of the cord. As regards this second point the physical conditions are not sufficiently analyzed (either in this volume or in the original paper) for us to admit, *e.g.*, that average galvanometric swings of 60 and 20 indicate a passage of afferent impulses in the proportions 60 and 20 per cent. in the posterior and in the lateral columns respectively. That the deflection was proportional to the number of fibres excited, is an assumption requiring proof (p. 212, *cf.* also pp. 145, 159, 160).

As regards the first point, it was found that electrical discharges pass easily *down* as well as *up* the posterior root, but are "blocked" *up* the anterior root, and diminished *down* that root. But in the inferences *qua* functional impulses derived from these data, two considerations appear to have been insufficiently borne in mind—(1) The rapid death of interrupting grey matter as compared with the endurance of white matter, and (2) the disproportionate magnitude of negative variations by *electrical* excitation as compared with negative variations by *functional* excitation. The contrast between interrupted and non-interrupted tracts, as regards the transmission, gauged electrically, may have been in part due to the first cause, and an adequate recognition of the second fact would have withheld Prof. Horsley from expressing astonishment—"a revelation to us" is his phrase—at finding the electrical variation in a nerve eight or ten times as great by direct electrical excitation as by discharge of a nerve centre. Du Bois-Reymond's analogous deflections obtained on strychninized frogs were 1° to 4° *versus* 40° by direct electrical excitation. A functional discharge *down* posterior roots, if proved to occur, is a new and surprising phenomenon; but its existence is not *at present* proved by the existence of an electrical discharge; electrical effects by electrical excitation are tainted evidence, electrical effects down the posterior roots by functional excitations above, although incidentally touched upon, were not exhaustively examined, and considering the recognized dangers of experimental fallacy, we may not admit as proved that nervous impulses are discharged down afferent channels. Prof. Horsley infers unreservedly that functional discharge occurs *down* the posterior roots, and that centripetal impulses *up* the anterior roots are blocked at the cord. This he regards as striking evidence of the truth of the kinæsthetic doctrine (*i.e.*, that nerve action starts from the afferent or sensory side of the nerve centre, p. 170); but the connection between this presumed functional downflow in afferent channels and kinæsthesis is not made apparent; up-flow in afferent channels is matter of common knowledge; up-flow by efferent channels has (so far as we know) been contended for by no one since Lewes. But as regards these last points, they may be expected to receive fuller and more precise analysis in the promised volumes on the brain and on physiological psychology. A. D. W.

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[1] In point of time Brown-Séquard is the true discoverer of vaso-motor nerves. Bernard's experiments were made subsequently, and interpreted otherwise.

"D'après ces expériences, il n'est donc pas possible d'expliquer le réchauffement des parties par une prétendue paralysie des artères, qui, à raison d'un élargissement passif, laisseraient circuler une plus grande quantité de sang. . . . .

"Si alors [*i.e.*, en galvanisant] les artères, comme les veines, se ressèrent et reviennent sur elles-mêmes, çela tient à ce qu'il n'y a plus de sang pour les distendre, mais ce n'est pas du tout l'effet d'un resserrement actif des vaisseaux.

. . . . . "il ne peut venir à l'idée de personne de penser à rapporter [le phénomène circulatoire qui succède à la section du nerf sympathique] à une paralysie pure et simple des artères." Bernard, *Annales des Sciences Naturelles*, 1854, p. 198.)

ELECTROTECHNICAL TRAINING.

Electrical Engineering as a Profession and How to Enter It. By A. D. Southam. (London: Whittaker and Co., 1892.)

THIS book consists of a collection of extracts from the notices of various firms regarding apprentices and articled pupils, and from the prospectuses of colleges which give an education in electrical engineering. It reminds us of the gorgeous but depressing volumes one has met so often in one's summer outing, containing particulars of hotels in Aden, hotels in Algiers, hotels in Andermatt, &c., each hotel possessing, at least so it is said in the gilt-edged page advertisement, every possible attraction—a magnificent view, a first-rate cuisine, electric light, ascenseur, and all the other dreariness of a bandboxy barrack.

First we thought that the length of description which the author had given to a particular technical educational establishment was a measure of its goodness, but that idea we dismissed when we found that only three pages of description were given to that technical college in South Kensington, regarding which the author says: "This institution deservedly stands at the head of all the technical institutions in this country." Next it occurred to us that the author might have acted on the "good wine needs no bush" principle; but that hypothesis had to follow the other, for we feel sure that the Walker Engineering Laboratory at Liverpool is not bad, and yet it requires fifteen pages of talking about. Then we wondered whether each professor had been asked to write as much as he liked, so that the length of the description of a particular set of laboratories was in proportion to the leisure of the writer; and lastly, we have been speculating whether the likeness to the "Hotels of the World" book might not be quite complete, and the length of the description was a measure of the length of the purse of the advertiser.

However, be the plan of the compilation what it may, the book contains a good deal of information, also some salutary advice with which we quite agree:—"Undoubtedly the best training for a young man entering the electrical profession is to go through the course at one of the technical schools or colleges, and then when thoroughly grounded in the theory and having a general idea of the practice of his profession, to be articled for some months to a good firm of electrical engineers, where he will be able to acquaint himself with the practical part of his business as actually carried out on commercial principles;" and again, "if he then goes to both a Technical College and is also articled, it is advisable that the former should precede the latter, for the reason that when he is placed in the workshop his previous technical training will enable him to appreciate and see the importance of much which he would otherwise have overlooked."

For the fathers who desire to place their sons directly in a works on leaving school, there is given a long list of engineering firms who are willing to receive £300 and the lad; some are willing to take only one hundred and twenty guineas a year, from year to year, or even as little as £100 a year—and the lad. In many cases a month's trial is allowed, but judging from the ignorance of elementary mathematics and science displayed by many articled pupils in works, we presume that either these subjects are not required, or a month is not a long enough time for this astonishing ignorance to be discovered. Naturally enough these firms do not bind themselves to provide work for these articled pupils when their term is finished; indeed we know of a firm with over 100 articled pupils which is applying elsewhere for an assistant.

When will the parental idea die out that a lad who is pitchforked into a works must turn out an engineer? No doubt many of our successful engineers never received any education in a technical college; so many of our battles were won by men armed only with bows and arrows, but that is no reason for confining the equipment of a modern regiment to these primitive weapons. Either the teaching given at a technical college materially helps the lad in his subsequent practice in the works, or it is a fraud and ought to be stamped out. If it affords real help to the lad, then why, we ask, do not the firms insist on their pupils obtaining it before they enter the works?

Mere evening instruction for a lad who has been hammering, say, from 6 a.m. to 6 p.m. is well-nigh useless, and at the best ought to be regarded only as a makeshift for those who are compelled to spend the day earning their living. To place a lad at a technical college for two years, and then for two years at a works would cost, as far as fees and premium are concerned, about £250. To article him for three years at the works about £300. When will parents see that the cheaper course is far the better, and when will firms refuse to take an articled pupil unless he has already acquired that theoretical knowledge which is necessary to enable him to benefit by a works training? The father who articles his son to an engineering firm immediately the lad leaves school and expects him to pick up his technical education at odd moments, may be more liberal in his money, but certainly is no more liberal in his ideas than the parents who sent their sons to receive their practical training at Dotheboy's Hall. "Now, then, where's the first boy?" "Please, sir, he's cleaning the back parlour window." "So he is, to be sure," rejoined Squeers. "We go upon the practical mode of teaching, Nickleby. . . C-l-e-a-n, clean, verb active, to make bright, to scour. W-i-n, win, d-e-r, der, winder, a casement. When a boy knows this out of a book he goes and does it."

P. D.

HYGIENE AND PUBLIC HEALTH.

A Treatise on Hygiene and Public Health. Edited by T. Stevenson, M.D., F.R.C.P. (Official Analyst to the Home Office), and Shirley Murphy (Medical Officer of Health of the Administrative County of London). Vol. I.

THIS is a treatise consisting of various contributions from different writers. In the selection of authors it has been wisely decided not to limit the choice to members of the medical profession, and the wisdom of this decision has been exemplified in the acquisition of two of the very best articles which the book contains, *i.e.* that by P. Gordon Smith, F.R.I.B.A., and Keith D. Young, F.R.I.B.A., entitled "The Dwelling," and that by W. N. Shaw, F.R.S., headed "Warming and Ventilation."

There are at present several excellent small works upon hygiene and public health, but these of necessity treat of the subject in far too cursory a manner—indeed, they are designed more to meet the repuirements of candidates for the Public Health Diplomas now granted by many examining Boards. This work is evidently intended as a book of reference, and there is no doubt that it will be of great value to those from whom a special knowledge of public health work is demanded. While, then, the last year or two have been remarkably fruitful in the production of works upon the subject here treated of, the volume before us will not be one jot the less appreciated on this account, for it meets a want which must long have been felt among those who desire a better and more inclusive knowledge of public health matters than was hitherto accessible in a collective form.

It is needless to insist that the work is all well done, and that any shortcomings must, of necessity, be faults of omission rather than of commission, for the list of contributors includes those who occupy some of the foremost positions as authorities upon the subjects of which they treat. It is not an easy task—and one is conscious of running great risk of appearing arrogant—to single out those sections especially deserving of praise. If this is permissible in such a work, we should point to the two articles already mentioned as occupying a foremost place—indeed, the article upon "Warming and Ventilation" is a little too exhaustive and technical in its physical aspect, and deals too briefly and sparingly with the commoner provisions now used for both the purposes of warming and ventilation;—a shortcoming which has the effect of somewhat sacrificing the practical utility of the article to its bulk, when viewed from the health officer's standpoint. It would not be easy to speak in terms too high of the all-round excellence of the article upon "Disposal of Refuse," by Prof. W. H. Corfield, M.A., M.D., and Louis C. Parkes, M.D., D.P.H., and the work of compiling this section could not have been entrusted to more capable hands. "Water," by T. Stevenson, M.D., is a capital article, but one would like to have seen in it more about the methods of collecting water and distributing it, and of the risks which the water runs of pollution in and around dwellings.

In the preface we read that "it has been the desire of the editors that the several papers which these volumes contain should present a fair account of the knowledge, so far as obtainable, of the subjects of which they treat"; and this is invariably achieved, for where the account is not an excellent one, it is always more than a "fair" one.

The contribution upon "Air," by Prof. J. Lane Notter, M.A., M.D., is too short, and does not nearly include all the material given in his edition of Edmund Parke's work; and the same fault may be found with the articles upon "Hospital Hygiene," by H. G. Howse, M.S., and "The Inspection of Meat," by E. W. Hope, M.D., D.Sc.

"Systematic Physical Education"—a subject which has been all too little studied in this country—is well and spiritedly treated of by F. Treves, F.R.C.S.

The articles upon "Baths," by H. Hale White, M.D.; "Clothing," by G. V. Poore, M.D.; "Food," by Sidney Martin, M.D.; "Soil," by S. M. Copeman, M.A., M.D., D.P.H.; "Meteorology," by G. F. Symons, F.R.S.; "The Influence of Climate upon Health," by C. T. Williams, M.A., M.D.; "Offensive and Noxious Businesses," by T. W. Hime, B.A., M.D.; and "Slaughter Houses and their Administration," by E. W. Hope, M.D., D.Sc., are all good, though some of them might have been fuller. The article upon "The Influence of Climate upon Health" might with advantage have considered much more fully the reasons why the various climatic conditions influence the health of man in the way they do. The contribution upon "Meteorology," which is capitally illustrated, and one of the most useful in the book, might also have considered the physical causes which affect the readings of the various instruments, and dealt more fully with the principles upon which these are constructed. The article upon "Food" is excellent in some respects, but an attempt to convey to the reader, in an abstract form, the methods of food analysis fails—as it always does when such a subject is treated of in brief space—to be of great assistance to the reader.

The index is good, and the book is a valuable addition to Public Health literature.

OUR BOOK SHELF.

Lehrbuch der Botanik nach dem gegenwärtigen Stand der Wissenschaft. Bearbeitet von Dr. A. B. Frank. Erster Band: Zellenlehre, Anatomie und Physiologie. 8vo. 670 Seiten, mit 227 Abbildungen in Holzschnitt. (Leipzig: Wilhelm Engelmann, 1892.)

THIS is essentially a fifth edition of Sachs's renowned "Lehrbuch der Botanik," the fourth and last German edition of which appeared as long ago as 1874. An English edition, emended and augmented by the translator, Dr. S. H. Vines, was published in 1882. Now, ten years later, Dr. Frank has written a completely new work. As the author tells us in his preface, he was requested in 1890 to prepare a new edition of Sachs's book; but he has adopted the wiser course of making himself responsible for the whole. Nevertheless, free use has been made of Sachs's excellent illustrations, upwards of ninety out of the two hundred and twenty-seven having been taken from that source, "because the author could not replace them by better ones." About sixty are borrowed from other authors, and about seventy of them are original, or at least Dr. Frank's own, for some of them have appeared elsewhere. A number of them are reduced from Frank and Tschirch's "Wandtafeln." Certainly the book is admirably illustrated. In the limitation and arrangement of the material the author has followed Sachs in a general way, though he has separated the physiology and anatomy from morphology and classification. The two latter branches are to be dealt with in a second volume, promised early next year. So far as the present volume is concerned, we can strongly recommend it to the student familiar with the German language. It is written in a clear, succinct style; and, so far as we have been able to test it, it is well up to date. Dr. Frank is well known as a writer and teacher of botany, and especially for his researches and experiments relating to the nutrition of plants. The sources of the nitrogen of plants and symbiosis are two subjects to which the author has devoted much attention, and they are discussed in some detail from his own standpoint. We are glad to see that copious and complete references are given to the books and articles of the principal writers on the various subjects, whose views are discussed or adopted. Unfortunately there is no index, and it is not easy to find one's way through the table of contents. True, a "carefully prepared" index is promised with the second volume, but a separate one to each volume would be far more convenient and time-saving. It is not as though the second volume was a continuation of the first; and it is to be hoped that the author and publisher will even yet see their way to provide this facility for using the work.

Arithmetical Chemistry. Part II. Book B. By C. J. Woodward, B.Sc. (London: Simpkin, Marshall, Hamilton, Kent, and Co. Birmingham: Cornish Bros., 1892.)

THE student will find in the present edition of this work what is practically a new book, as the author has enlarged and entirely rewritten the original publication. The opening lessons treat of analyses, the formulæ of minerals, Dalton's law of partial pressures, gas analysis, &c., and are on the whole satisfactory. The introductory portions of the lessons, which embody the principles involved in the exercises, and contain typical examples fully worked out, are clear, as a rule, and the exercises themselves are both suggestive and useful. The same may be said of the concluding part of the book, wherein are briefly discussed atomic weight determinations, and the various means of controlling atomic weights, calorific power and intensity, heats of formation, dissociation, and gaseous phenomena, comprising the kinetic theory, diffusion, and absorption by water.

The intermediate lessons on molecular weights are, however, not up to the standard of the others. It is not made plain when discussing Avogadro's law that a vapour density observation, when possible, is the decisive mode of fixing the molecular weight of a compound. The vague description of the apparatus used in measuring osmotic pressure can only confuse the reader, and loose statements such as "*solutions* behave as gases," p. 51, must have the same effect. The relationships established in connection with the vapour-pressures of solutions only hold if the dissolved substance is practically non-volatile, this point is omitted, and the definition given of equimolecular solutions is not the one in common use. Indeed, the entire treatment of the properties of solutions as applied to molecular weight observations, although it may perhaps enable the student to solve problems, is much too fragmentary and loosely put together to give him an adequate idea of what is known on the subject. It may also be pointed out as somewhat late in the day to give a few of Kopp's conclusions as an account of specific volume.

Among minor corrections it may be noted that on p. 6, in the first erratum, solvent should be solution, vapour-tension might often be replaced by vapour-pressure, xylol should be xylene, and amyl benzoat should be amyl benzoate, on p. 48. "Ostwald's Solutions" might be included in the list of English works to which the student is referred.

The book contains an index, a list of answers, and a collection of the questions in arithmetical chemistry set at the Honours examinations of the Science and Art Department, and at the B. Sc. examinations of London University. A portion of the author's A B C Five-figure logarithms is presented with this edition. J. W. R.

Lessons in Heat and Light. By D. E. Jones, B.Sc. (London: Macmillan and Co., 1892.)

THE success of a previous work on "Heat, Light, and Sound," has led Prof. Jones to extend the two former parts, and publish them separately for the use of schools and junior classes in colleges. As an introduction to the study of experimental physics, the book cannot fail to be of great value. The principles of the subjects are very clearly stated, and the experiments from which they have been deduced are fully described. Most of the experiments may be easily performed by students, the instructions being sufficiently clear to guarantee success. Numerous arithmetical examples, partly selected from the author's "Examples in Physics," are added at the ends of the various chapters. The physiographic bearings of the subject of heat have been brought well to the front; thus the origin of the Gulf Stream, trade winds, and the formation of rain and snow are explained. Many of the diagrams have been carefully drawn to scale, in order to give the student an idea of the dimensions of the apparatus which may be conveniently employed in performing the experiments.

Elements of Magnetism and Electricity. By John Angell, F.C.S., F.I.C. (London: Collins, Sons, and Co., 1892.)

THIS is a new edition of one of the best-known text-books for use in connection with the classes under the control of the Science and Art Department. The book calls for no special remark; but the fact that a hundred thousand copies have already been disposed of seems to demonstrate its usefulness. Experiments and illustrations are its special features.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Further Notes on a recent Volcanic Island in the Pacific.

THE volcanic island—Falcon Island—in the Tonga group in the Pacific, of the recent appearance of which an account is given in NATURE, Vol. xli., p. 276, has recently been passed by a French vessel of war, the *Duchaffault*, which reports that the island is not now more than 25 feet high.

In October, 1889, when examined by Commander Oldham, it was 153 feet high, and a little over a mile long. Nearly entirely composed of ashes, it was rapidly washing away, and by the account above, it would seem that more than one-half the island must now have disappeared. W. J. L. WHARTON.

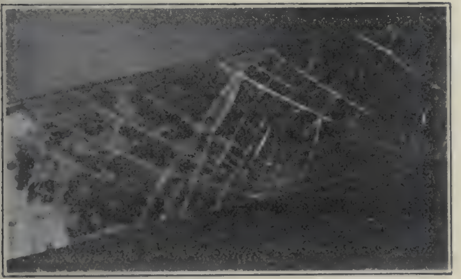
October 20.

Earth-fractures and Mars "Canals."

ON seeing the figure of the so-called "canals" of Mars, published in NATURE of a few weeks back, I was at once reminded of the pattern assumed by the cracks of glass broken by torsion, as in Daubrée's well-known geological experiment.

I enclose a photograph of part of a large slab of glass broken in this way in a class experiment of my own, and although other slabs, which have unfortunately not been preserved, exhibited, if I remember rightly, still more Martial-looking networks, I think that the general resemblance is obvious enough in this case.

It may perhaps be well to explain to non-geological readers of NATURE that Daubrée's glass-breaking[1] is regarded by many as reproducing in miniature the kind of fractures which are found to occur in those portions of the earth's crust with which we are acquainted, and that by torsion only has it proved possible to imitate the peculiar pattern assumed by such fractures, whether they be joints or dislocations. It is further held by many that such lines of fracture in such patterns are a necessary result of the shrinking of the outer coat of a planet in course of cooling.



Mere fractures, such as we meet with in our own planet, could, of course, not be seen from any considerable distance, and if the circumstances of denudation were the same in Mars as with us, the "canals" could certainly not be the representatives of our usually hidden and featureless earth-cracks. There seems, however, to exist, in the extraordinarily rapid melting of gigantic ice-fields described by Prof. Norman Lockyer, some evidence of denuding power in Mars on a scale enormously larger than is the case with us. Earth-fractures—and for the matter of that Mars-fractures too—must many of them be lines of weakness along which denudation acts more freely than elsewhere, and if this denudation be phenomenal and cataclysmic, as appears to be likely in Mars, wide valleys or channels capable of being distinguished at great distances would soon be scoured out along them.

I would wish especially to draw attention to the three following points observable in the photograph, viz., the two marked directions in which the crack-lines run, one set crossing the others often at, or very nearly at, right angles; their occasional doubling and rough parallelism for some distance; and their frequent sudden stoppage—three of the features most noticeable in the Mars lines. G. A. LEBOUR.

Durham Coll. Science, Newcastle, October 13.

A Wave of Wasp-Life.

MR. HUDSON'S charming work on "The Naturalist in La Plata" reminds me of a very interesting wave of wasp-life which appeared in Wisconsin in the summer of 1886. We were living at the time in our summer-house at Pine Lake, and were making observations on the habits of the different animals in the neighbourhood.

In the latter part of July we suddenly found ourselves surrounded by large numbers of yellow-jackets and hornets. Everywhere through the woods and fields a veritable plague of wasps seemed to have descended upon the earth. During all the month of August we heard the same report from summer residents within a radius of twelve or fifteen miles of Pine Lake. In our immediate neighbourhood we knew of forty-seven nests. Allowing 1500 wasps to a nest—a very low estimate for that season of the year—this gave us over 70,000 wasps. Plates of meat and bones that were set outside for the cats were immediately covered with them, and in spite of screens in doors and windows they even entered the house, alighting on the food at the dinner-table, or darting about and catching flies.

The cause of this sudden increase in the number of wasps was evidently a general one, since it acted in the same way upon three species—*Vespa vidua*, *V. maculata* and *V. germanica*. An examination of the Signal Service statistics does not show anything unusual in the preceding winter and spring, but either the weather must have been especially favourable, lessening the ordinary death-rate of the queens, or there must have been a marked decrease in the parasites or other enemies which ordinarily keep these species in check.

The duration of the favourable conditions proved brief enough. It is probable that every one of our forty-seven nests furnished, at the very lowest estimate, one hundred developed and fertilized queens to start forty-seven hundred new nests in the following year; yet the increase in the checks to the too great ascendency of these species more than counter-balanced the abnormal increase. The winter of 1886-87 was not especially severe, but in the following summer the most careful search on our part, and on the part of others, whose efforts were stimulated by the offer of rewards, only gave us four nests in our neighbourhood, and on all sides we were met by the inquiry: "What has become of the wasps?"

G. W. PECKHAM.

Milwaukee, Wisconsin, October 12.

Note on the Occurrence of a Freshwater Nemertine in England.

A FEW days after reading M. de Guerne's "History of Freshwater Nemerteans," published in the August number of the *Annals*, I happened upon a specimen of the group amongst the roots of some water plants, which I collected in the river Cherwell, close to Oxford. I was, at the time, searching for the cocoons of a new Rhinodrilid worm, of which a description will shortly appear. The gathered roots, with the cocoons, were placed in a bottle of water, in order that the worms might hatch out. On examining the bottle two days later, namely, on September 5, I noticed a small bright orange animal, about half an inch long when extended, creeping amongst the cocoons. Further observation with the microscope showed that it was a species of *Tetrastemma.* Unfortunately the animal was crushed before I had done more than sketch the general appearance and make some few observations, and I have not yet succeeded in finding more specimens; so that I am unable to state how far it agrees with or differs from the previously known freshwater forms enumerated by M. de Guerne, most of which are included by Silliman and later authors under the title *Tetrastemma aquarum dulcium.*

In one or two points, however, my sketches show certain differences from those of Silliman:—

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[1] Not "*ice*-breaking" as a mistranslation of the word "glace" has caused it to be described in some English text-books.

(*a*) The colour (orange) is due to pigment in the skin, and not to the red colour of the nervous system; I may mention that Dugès' species, "*Prostoma clepsinoides*," was yellow ochre, and "*Pr. lumbricoideum*" was yellow marbled with red; whilst Leidy's "*Emea rubra*" was yellowish flesh-coloured (probably due to the hæmoglobin in the nervous system).

(*b*) The anterior pair of eye-spots is further from the prostomium than in Silliman's drawing; I found no third pair of eye-spots, which, however, it is stated, is absent in the young.

(*c*) The ciliated pits are further forward, being midway between the brain and the anterior end of the body.

(*d*) The proboscis and its retractor muscle are much more undulating, when withdrawn into the body, than Silliman shows.

The proboscidial spine, with its groups of accessory spines, agrees very closely with the figures given by Silliman.

I can say nothing about the generative organs. For the present, then, I must leave undecided the specific name of this British *Tetrastemma*. W. BLAXLAND BENHAM.

Anatomical Department, Museum, Oxford,
Oct. 12.

Protective Mimicry.

MR. BATESON's letter on "Aggressive Mimicry" (NATURE, October 20) recalls to my mind a curious case of protective mimicry which came under my notice last August on Dartmoor. Large patches of the heath had been burnt, a common practice on the moorlands to ensure a fresh young growth for the sheep. The whole ground was alive with a common species of orthoptera (Locustina), the small green grasshopper with short antennæ. They leapt aside at every step in the short grass and scrubby heath; upon the burnt patches they were equally numerous, but with this difference—all, without exception, were coal black on abdomen, thorax, and head, whilst the wings were of an ashen hue. So much did the colour adaptation resemble the blackened turf and heath they hopped amongst it was almost impossible to follow them with the eye; we made many amusing attempts, but were nearly always defeated. I measured one of these burnt patches, and found it to be from thirty to forty yards square. A yard or two from this, on the untouched herbage all the Locustina were bright green. I found one specimen on the borderland in a transition state, not dull all over as I had expected, but in spots and patches of bright green and black. One enemy at least of these insects abounded on the moor, namely, the common lizard (*Zootæa vivipara*), for I have observed there is no food lizards will eat more greedily than grasshoppers. I have seen some that I have in captivity swallow twenty or thirty in two or three minutes, even after their usual meal of worms. They always became greatly excited, if one may apply so warm an expression to such cold-blooded animals, and rushed about the case when a collection of live grasshoppers were thrown to them. Certainly I was much struck by the rapid action of the power possessed by these Locustina on Dartmoor of assimilation to environment, and did not doubt but that this colour adaptation was for the purpose of protection, the eye producing by reflex action the change in the pigment cells. ROSE HAIG THOMAS.

STELLAR PARALLAX.[1]

THE Delegates of the University Press have recently published the results of Prof. Pritchard's systematic investigations into the parallax of those stars of the second magnitude whose North declination permits the inquiry to be made with facility and advantage in these latitudes. Our first feeling on glancing over the contents of this *brochure* must be one of hearty congratulation to the distinguished professor that he has been permitted to see the full outcome of a protracted inquiry, conducted at a period in his life when a less energetic astronomer would have felt himself justified in withdrawing from active participation in scientific research. Prof. Pritchard might well have been content to rest on the laurels he had won, and to have staked his reputation upon that career of acknowledged utility which has marked his direction of the Oxford University Observatory.

Immediately on the completion of the photometrical examination of Argelander's Uranometria, and with a zeal that admitted of no delay, Professor Pritchard busied himself with this inquiry into the parallax of stars of the second magnitude. But if the inquiry was undertaken with eagerness, and pursued with ardour and resolution, it was not characterized by hurry, or its success imperilled by incompleteness. Confident himself that photographic methods possessed the requisite accuracy to make the research successful and trustworthy, the Savilian Professor set to work to establish the reliable character of measurements made on sensitized films, and not till that confidence was demonstrated did he embark upon the larger work now under notice. These preliminary inquiries have been published in a series of papers in the proceedings of the Royal and Royal Astronomical Societies, and the confidence gradually acquired by enlarged experience induced him to proceed with the determination of the parallax of 61 Cygni, the results of which are published in detail in the third fasciculus of the Annals of the University Observatory. In this case he selected four stars in the immediate neighbourhood of the principal star, and sought the difference of parallax between each of the components and of the four stars of comparison. This long research may be regarded by some as a work of supererogation, inasmuch as the labours of Bessel and that of many later astronomers have satisfactorily settled the parallax of this star within very approximate limits. But if we properly understand the motives of Prof. Pritchard, his intention was not so much to seek anew the parallax of that system, as to discover with what degree of accuracy the method of photography, hitherto unapplied in this direction, represented the work of others made directly in the field of the telescope. Nor was this his only view. By selecting four stars in the immediate neighbourhood of 61 Cygni and seeking the difference of parallax between these stars of comparison and each of the components of the system, he instituted a very severe inquiry as to the trustworthiness of that method, which he had imagined as capable of dealing with the delicate question of stellar parallax. The severity of the test consists in deducing the same value of the parallax (eight in all) from each set of measures, and as a matter of fact the accordance, *inter se* between these several determinations is as close as could have been anticipated, and likewise in satisfactory unison with the work of other astronomers.

The completeness of this inquiry and the publication of it in detail have had two happy results. In the first place, Prof. Pritchard has, in the present instance, been able to confine the printing within very narrow limits, so narrow, indeed, as possibly not to have done himself justice. The details of his process, the mutual agreement of his measures, and his method of discussion having all been fully set out in his previous work, he has not felt himself obliged to enter into these minute particulars, but has contented himself with presenting the results. This method of arrangement, no doubt suggested in the first place by economical motives, has afforded opportunity for adding a very interesting history of the processes and results that have hitherto been followed with more or less success by others, and also the exhibition in a concise form of the different values of the more trustworthy determinations, derived by previous observers. The second advantage, immediately arising from the earlier investigations, is, that an examination of those results has shown that no increase of accuracy (commensurate with the increased labour at least) was obtained by continuing the observations of the stars throughout the whole of the year, that is, to secure observations in all positions of the parallactic ellipse. If the measures were confined to those epochs when the parallactic displacements were greatest, and a sufficient number of observations secured at those critical times, a determination of parallax could be relied upon to within about one-thirtieth of a second of arc. This is approximately the limit of accuracy that Professor Pritchard hoped to reach, and in this selection he appears to have been guided by the conviction, that in the present condition of cosmical inquiries, to which stellar parallax bears the closest relation, it is of more importance to know within very narrow limits the parallaxes of many stars than seek with the utmost accuracy the parallax of a very few. And in this respect there can be no doubt but that Prof. Pritchard's judgment is correct. The former is the view of a philosopher; the latter that of a conscientious and painstaking observer. Guided by the broader view, the result of his work has been to enrich the data at the command of students of cosmical science by assigning the approximate distance to some thirty stars, a number which bears no inconsiderable proportion to the total number of separate determinations made by all other astronomers combined.

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[1] "Researches in Stellar Parallax by the aid of Photography." By Charles Pritchard, D.D., F.R.S., Savilian Professor of Astronomy in Oxford.

Prof. Pritchard's view of the history of stellar parallax is that of a scientific struggle, a continual and severe wrestle on the part of the astronomer with the inevitable inaccuracy of observation and imperfect instruments, in which sometimes one opponent, sometimes the other, has the mastery. He passes in his historic survey rapidly over those days when from various obvious causes the detection of stellar parallax was scarcely possible, moved however to admiration by, and induced to linger over, the success that attended the early observations of Molyneux in the case of γ Draconis when discussed, a century later, by Auwers, a success that later observers have struggled to repeat ineffectually. He brings before us, but touches with a light and kindly hand, the dispute that embittered the lies of Brinkley and of Pond, but it is not difficult in reading a little between the lines to see with whom his sympathies rest. Later on in the history of the research, Henderson meets with his deserts, as a clear-sighted astronomer of distinguished ability, cautious and persevering, and one who in the struggle after accuracy obtained an undoubted measure of success. This historical introduction will we think be read with pleasure by many who may have no particular interest in this special subject of inquiry. The comments of one who has encountered and overcome many similar difficulties, and has kindly sympathy with all who have travelled along the same path, cannot but be of interest and of value, and we could have wished that this portion of the book had been considerably extended. How many astronomers are now acquainted, with any degree of adequacy, with the serious difficulties that attended the early application of the heliometer in this department of research, and with the dispute that raged long and dubiously around the names of Wichmann and of Schluter? All are willing to admit that in the hands of many competent observers—it would be invidious to mention any without naming all—the heliometer is doing splendid work, but the difficulties with which the early masters had to cope are now all but forgotten, and it is certainly wise to treasure a sympathetic remembrance for the earlier exponents of the improved and successful methods now in vogue.

The last portion of Prof. Pritchard's history is occupied with the bearing of stellar parallax on the problem of the construction of the stellar universe. He seems to have had before his mind two questions, which, long hovering in an unexpressed form, were first formally enunciated by Dr. Gill. The first question is, What are the average parallaxes of stars of the first, second, third, and fourth magnitude respectively compared with those of fainter magnitude? To this question the Savilian Professor replies very cautiously. The researches of Dr. Elkin on stars of the first magnitude point to an average parallax of 0″·089 for stars of that class, and just as certainly Prof. Pritchard's researches point to an average parallax of 0″·056 for stars of the second magnitude. But he pertinently asks what can be understood by an average of distances (as indicated by parallaxes) in cases where the separate elements vary from actual zero to half a second, and where moreover many of the brighter members are the furthest removed from us? Notwithstanding these exceptional cases, which challenge attention, the fact remains, and it is apparently the only conclusion which can be drawn with any certainty, that the stars of the first magnitude are on the whole nearer to us than those of the second, and that these again are as a whole nearer to us than the faint stars with which they have been compared. With conclusions of this sort it would seem that astronomers will have to content themselves for some time to come.

The second question which Dr. Gill suggested or formulated was—What connection does there exist between the parallax of a star and the amount and direction of its proper motion?—or can it be proved that there is no such connection or relation? The answer given to this second query is even less satisfactory than to the former. Prof. Pritchard contents himself by exhibiting in a tabular form the parallax and the proper motion of all stars that have been successfully handled, and the only conclusion drawn or warranted, is a suggestion that there is at least quite as close a connection between the apparent proper motion of a star and its distance from us, as there is between its distance and its magnitude.

If we examine or attempt to trace any connection between the mass, the brilliancy and the distance of a star, we are baffled by the same kind of uncertainty, arising in some measure from the paucity of instances in which it is possible to make the inquiry, and we are reluctantly forced to admit that such investigations are premature. At least that would be the conclusion of an ordinary mind, but here it is that Prof. Pritchard sees his opportunity for future efforts and renewed vigour. With an energy that must be the admiration of his friends, he selects for further investigation two subjects, either of which might fully occupy the time and the hands of a younger man. He proposes in the first place to determine the parallaxes of several stars of the Pleiades, a few of the brighter as well as a few of the fainter, with the view of discovering whether the faint and the bright are indiscriminately mixed at that distance. The second subject of his proposed inquiry is not less interesting. It consists in the investigation of the distances of some of the binary systems from our sun; and from a more complete knowledge of the masses, the mutual distances, and the parallaxes of these systems, Prof. Pritchard thinks it not unlikely that many interesting and possibly unexpected associations may reasonably be anticipated, thereby affording us some further insight into the constitution and the mechanism of the Stellar Universe. We can only hope that Prof. Pritchard's health and strength may be spared to witness the completion of this programme, but in that case we are assured he would immediately sketch out for himself some new field of inquiry, and court even longer and more protracted labour.

CONTRIBUTIONS TO THE STUDY OF DISINFECTION.[1]

PROFESSOR J. MASCHEK, whose name is already familiar to us through his investigations on water bacteria, has brought together in pamphlet-form a large number of experiments on the relative value of various disinfectants and disinfectant processes. Since the introduction of Koch's methods, the study of the subject of disinfection has been immensely assisted, and it is now possible to take a more accurate measure of the extent to which micro-organisms are affected by different treatment, whether chemical or mechanical. The stimulus which it has thus received has not unnaturally drawn a large number of workers into this particular field of inquiry, and the literature is already very unwieldy.

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[1] "Beiträge zur Theorie und Praxis der Desinfection, von Prof. J. Maschek." Im Selbstverlage des Verfassers, Leitmeritz.

One of the principal difficulties which surround the study of micro-organisms is their individuality, their apparent idiosyncrasies, and this is not confined to closely allied varieties, but is found amongst members of one and the same species. Thus, the previous history of a micro-organism, the nature of the culture material used, the temperature at which the cultivation has been kept, the age of the growth, &c., are all points which have to be taken into consideration as likely to influence the behaviour of the particular specimen under observation. This sensitiveness of bacteria may possibly to some extent account for the discrepant results which have been obtained by different investigators, although working in similar directions, which has rendered the accurate appreciation of the value of these results a by no means easy task. Again, what succeeds in a laboratory is not necessarily equally successful when carried out on a large scale, and it is this difficulty which has so frequently led to such disappointing results in actual practice.

Prof. Maschek has endeavoured by a series of most arduous and painstaking experiments to throw a little more light on some of the problems of disinfection, and in gathering up his work has wisely abstained from attempting an exhaustive survey of the general literature, restricting himself to a brief introduction and particular reference to those investigations with which he has been more closely concerned. In the majority of the experiments the author employed Koch's well-known method of sterilized silk threads, each of which was subsequently impregnated with pure cultivations of a number of different pathogenic micro-organisms. These were distributed in various parts of a room about 19-ft. long, 13-ft. wide, and 15½-ft. high, on the ceiling, walls, corners, floor, &c., whilst in some cases they were wrapped up in different materials, such as filter-paper, muslin, linen, in order to imitate as nearly as possible the actual conditions under which the organisms might be supposed to be present in an infected room. In each case, after the application of the disinfectants under observation, these silk threads were submitted to plate-cultivation, and in some instances their pathogenic properties were also tested by inoculation into animals.

The first elaborate series of experiments was made with the vapour of corrosive sublimate, which some authorities have recommended as an effective germicidal agent; but quite apart from the difficulty of getting rid of the poisonous crystals of corrosive sublimate which remained attached to various parts of the room, Prof. Maschek was not able to obtain satisfactory results, although every precaution was taken to ensure success. In this respect his experiments differ from those of König, who confidently recommended its use for disinfection purposes. The effect of chlorine gas was next tested and applied both in the dry and damp state. The results were, however, far from encouraging, for even when employed in the damp state the spores were not destroyed. In connection with these experiments a very instructive instance is given of the signal failure which accompanied the use of chlorine in the Alexander Hospital in St. Petersburg, which was designed for receiving different infectious illnesses. Suspicion as to its efficacy was first aroused after its use in the disinfection of a ward in which diphtheria patients had been treated. This ward was afterwards used for scarlet fever cases, and subsequently complications with diphtheria made their appearance, in consequence of which the ward was closed and disinfected with chlorine. (A ward of 900 cubic metres capacity being subjected to the chlorine gas evolved in treating 50 kilos. of chloride of lime with 65 kilos. of hydrochloric acid.) After the disinfection was completed, the ward was thoroughly cleansed and ventilated, and allowed to remain empty for seven months. On its being re-opened for the reception of measles cases complications with diphtheria again arose, although the patients when taken into the ward were wholly free from diphtheria. The measles patients were therefore removed, and the ward was again disinfected with chlorine, only this time a much larger quantity was employed (135 kilos. of chloride of lime with 148·5 kilos. of hydrochloric acid) after which it stood empty for another seven months. Later on cases of smallpox were received into this ward, but diphtheria again appeared, the physician, two nurses, and an attendant being amongst those attacked, whilst complications with diphtheria again occurred amongst the patients. In consequence of this the unfortunate ward was once more closed and thoroughly disinfected with chlorine, and was reopened for typhoid fever patients; but all children's cases were rigorously excluded, in consequence of their particular susceptibility to diphtheria. After the adoption of this special precaution no further attacks of diphtheria were met with. It might, however, be urged that as regards the infection of patients suffering from measles with diphtheria, the disease was possibly introduced from outside, and did not necessarily arise in the ward itself, were it not for the fact that there were three other wards in the hospital in which cases of measles were being treated at the same time, and no single attack of diphtheria occurred. Krupin, who is the authority for these facts, confirming the valuelessness of chlorine for disinfecting purposes, found that the spores of anthrax were not destroyed in a hospital ward after being exposed to the action of this gas for more than 40 hours.

A large number of experiments were made with a view to determining the number of micro-organisms present on the walls of a room. For this purpose a small sterilized bit of sponge cut in the shape of a cube (of about half-inch side) was used to rub down a measured portion (about 4 square inches) of the wall. The sponge was afterwards placed in a tube containing sterile melted gelatine and rotated gently, so as to disengage all the organisms on its surface. The gelatine was then allowed to congeal on the sides of the tube, and after suitable incubation the colonies made their appearance, and were estimated in due course. It was found that the numbers present on the walls and ceiling respectively varied considerably. Near the floor the number was much greater than on the middle of the wall, whilst here again they were more abundant than on the ceiling. For example, on one of the walls, at a distance of rather more than an inch from the ground, as many as 2,871 microbes were found, whilst on the ceiling over a similar area only 85 were discovered. It was also noticed that those portions of the wall or ceiling which were exposed to currents of air from either the window or door exhibited generally a smaller number of bacteria than did places which were shielded from such draughts. Prof. Maschek further found that one rubbing was wholly insufficient to remove all the organisms from a given surface, and it was only after the process had been repeated five times that all bacterial life could be banished with certainty. Although the figures thus obtained are of interest by way of comparison, yet it is difficult to believe that they represent the *actual* numbers present. The accuracy of this method, originally devised by Esmarch, rests on the assumption that on placing the sponge in the tube of melted gelatine and rotating it gently (for if this were done violently the gelatine would froth, and the surface become covered with small bubbles, which would greatly interfere later with the counting of the colonies) all the organisms attached to the surface of the sponge would be removed. Now the sponge being left in the tube must necessarily obscure part of the gelatine surface; moreover, the interstices becoming soaked with gelatine, colonies would certainly develop within the sponge itself and escape detection, whilst it is quite inconceivable that gentle rotation would suffice to detach even all those organisms which are adherent even to the surface of the sponge.

Wall surfaces deprived of micro-organisms in the manner described above were subsequently sprayed with distilled water infected with different pathogenic bacteria, and after sufficient time had elapsed for these surfaces to dry, the effect of various disinfectants was tried. Numerous investigations are also recorded of the use of creolin, carbolic acid, and mixtures of the latter with solutions of corrosive sublimate. The effect of exposure to high temperatures, in apparatus specially constructed for the purpose, has also been tried, whilst the disinfection of sewage matters with lime is also carefully considered, and a large number of experiments recorded with the typhoid and cholera organisms.

The following interesting account is given as an illustration of the success which can be achieved in disinfection on a large scale. An epidemic of diphtheria broke out in a small village in Germany and proved particularly fatal amongst the children, indeed so alarming was its progress, that the Burgomaster was led to suggest the disinfection of the whole village. A public meeting was held and the inhabitants were instructed as to the nature of the epidemic, and the possibility of checking it by the combined action of every household. Public funds were devoted to the purchase and distribution of the requisite disinfectants, and during three days the whole place is described as smelling of carbolic, whilst in all directions windows and doors were to be seen wide open, a very unusual sight in the country, and more especially in the month of February when this occurred. The work of disinfection was carried on most systematically, every article which could not be either washed or baked was treated with a 5 per cent. solution of carbolic acid. In short, no efforts were spared to thoroughly disinfect everything, and the result was that although the epidemic before the commencement of this disinfecting crusade was steadily gaining ground, it suddenly stopped. This must be considered as a tribute to the sagacity and energy of the inhabitants; for, as Prof. Maschek points out, experience teaches us to expect a gradual decline, due to the possible weakening of the virus, so that towards the end of an epidemic the number of bad cases is lessened and recoveries are more frequent.

In conclusion the words of M. Duclaux may be appropriately quoted: "Les études sur les antiseptiques n'ont gagné que de s'encombrer de résultats qui se contredisent les uns les autres, et entre lesquels on ne peut faire un choix, précisément parcequ'ils ont été souvent obtenus en dehors des conditions d'une étude précise. Il faut donc abandonner cette méthode, scruter avec de plus en plus de soin la phénomène, faire de la science, en un mot." This "*faire de la science*" is precisely the spirit in which Prof. Maschek has carried out his experiments; the immense care with which they have been conducted, the ungrudging labour bestowed upon them should render his results a most valuable contribution to the subject of disinfection. It is only to be regretted that they are not published in a form in which they would be more likely to become known and appreciated.

GRACE C. FRANKLAND.

AN ETHNOGRAPHICAL SURVEY OF THE UNITED KINGDOM.

A CIRCULAR letter, which we have been asked to print, has just been issued on behalf of the Committee appointed by the British Association to organize an ethnographical survey of the United Kingdom. The Committee consists of Francis Galton, F.R.S., J. G. Garson, M.D., and E. W. Brabrook, F.S.A., representing the Anthropological Institute; Edward Clodd, G. L. Gomme, F.S.A., and Joseph Jacobs, M.A., representing the Folk-lore Society; H. S. Milman, Director S.A., George Payne, F.S.A., and General Pitt-Rivers, F.R.S., representing the Society of Antiquaries of London; Joseph Anderson, LL.D., Secretary of the Society of Antiquaries of Scotland; and A. C. Haddon, M.A., Professor of Zoology at the Royal College of Science of Dublin. The following is the circular letter:—

SIR,—The above-named Committee, in pursuance of the object for which they have been delegated by the Society of Antiquaries of London, the Folk-lore Society, and the Anthropological Institute, and appointed by the British Association, propose to record for certain typical villages and the neighbouring districts—

(1) Physical Types of the Inhabitants.
(2) Current Traditions and Beliefs.
(3) Peculiarities of Dialect.
(4) Monuments and other Remains of Ancient Culture; and
(5) Historical Evidence as to Continuity of Race.

As a first step, the Committee desire to form a list of such villages in the United Kingdom as appear especially to deserve ethnographic study, out of which a selection might afterwards be made for the Survey. The villages suitable for entry on the list are such as contain not less than a hundred adults, the large majority of whose forefathers have lived there so far back as can be traced, and of whom the desired physical measurements, with photographs, might be obtained.

It is believed by the Committee that such villages may exist in the districts with which you are acquainted, and, as you are eminently capable of affording help in this preliminary search, we have to request that you will do so by kindly furnishing the names of any that may occur to you, with a brief account of their several characteristics; mentioning at the same time the addresses of such of their residents as would be likely to support the Committee in pursuing their inquiry.

They would also be glad to be favoured with the names of any persons known to you in other districts to whom this circular letter might with propriety be addressed.

We are, Sir,
Yours faithfully,
FRANCIS GALTON, *Chairman.*
E. W. BRABROOK, *Secretary.*

All communications should be addressed to "The Secretary of the Ethnographic Survey, British Association, Burlington House, London, W."

NOTES.

THE Board of Trinity College, Dublin, on October 22 elected Dr. Arthur A. Rambaut, M.A., Royal Astronomer of Ireland, on the foundation of Dr. Francis Andrews. The election was made under the provisions of Letter Patent 32 George III., dated in 1792. The new Professor of Astronomy in the University of Dublin, graduated in 1881 as a Senior Moderator and Gold Medallist in Mathematics, since which period he has acted until now as Assistant at the Observatory at Dunsink

He is the author of several astronomical papers published in the Transactions of the Royal Irish Academy and of the Royal Dublin Society.

IT is proposed that a portrait medal of M. Hermite, the eminent mathematician, shall be struck in commemoration of his approaching seventieth birthday. The circular asking for subscriptions is signed by a number of well-known mathematicians.

THE following nominations have been made for the Council of the London Mathematical Society for the session 1892-3. The ballot will be taken on November 10. For President, A. B. Kempe, F.R.S.; Vice-Presidents, A. B. Basset, F.R.S., E. B. Elliott, F.R.S., Prof. Greenhill, F.R.S.; Treasurer, Dr. J. Larmor; Hon. Secs., Messrs. M. Jenkins and R. Tucker; other members, Mr. H. F. Baker, Dr. Forsyth, F.R.S., Dr. Glaisher, F.R.S., Mr. J. Hammond, Prof. M. J. M. Hill, Dr. Hobson, Mr. A. E. H. Love, Major Macmahon, F.R.S., and Mr. J. J. Walker, F.R.S. After the election of the Council Prof. Greenhill will read his Presidential Address.

IN consequence of the alterations in the rooms of the Chemical Society, the first ordinary meeting of the Society will be held on Thursday, November 17, at 8 p.m.

THE late Dr. C. A. Dohrn left his magnificent entomological collections, with the library connected with them, in trust to his son, Dr. H. Dohrn, who was directed to use them as the nucleus for the formation of a natural history museum in Stettin. Dr. H. Dohrn has now not only carried out his father's wishes, but has presented to his native town his own conchological collections and library.

THE Geologists' Association will hold a conversazione on Friday, November 4, in the Library of University College, Gower Street. Among the exhibits will be a series of photographs of the recent eruption of Mount Etna. These will be shown by Mr. F. W. Rudler.

MR. M. C. POTTER has been appointed to the Chair of Botany at the College of Science, Newcastle-on-Tyne.

THE annual meeting and conversazione of the Postal Microscopical Society took place at the Holborn Restaurant on the 20th inst. There was a good attendance, and many microscopical specimens were displayed. An address on polarized light was delivered by Mr. G. H. Bryan, the president.

THE following lectures will be given at the Royal Victoria Hall on Tuesday evenings during the coming month:—Nov. 1, Prof. A. H. Green, "Coal, what it is and how it was made;" Nov. 8, W. D. Halliburton, M.D., F.R.S., "The history of some famous epidemics;" Nov. 15, Hermann H. Hoffert, D.Sc., "Electric sparks and lightning flashes;" Nov. 22, Prof. Hall Griffin, "Among the hills of Asolo: an illustrated account of the poem 'Pippa Passes.'"

NATURALISTS who visit the Zoological Society's Gardens should not fail to go to the Insect House and see the Pratincole, which has lately been received, and is kept in a cage in this building. So far as we know, it is the first example of this curious form of plover that has ever been seen in captivity. The specimen in question does not, however, belong to the Pratincole of the south of Europe (*Glareola torquata*), which has sometimes occurred in this country, but to an allied African species—the Madagascar Pratincole (*Glareola ocularis*). The bird was obtained near Mombasa, in Eastern Africa, and presented to the society by Mr. R. MacAllister. It was carefully brought home, along with many other interesting specimens, from Zanzibar and the adjoining mainland by Mr. Frank Finn, F.Z.S., on his return from his recent expedition to that country.

A CORRESPONDENT from Tangier writes that during the recent mission to Fez of Sir Euan Smith, Mr. Walter H. Harris and Mr. Carleton, the interpreter, were informed by a cherif from Tafilelt, cousin of the Sultan, and Governor over an extensive district, that there is no question as to the existence of dwarf tribes down the Dra, where they are very numerous. Sir Euan Smith was told of this statement, and probably had a talk with him. Mr. Harris intended to have taken a trip down the Dra to Akka, but was convinced from what he heard that such a trip would be an act of suicide. He however believes that he can get full information as to the dwarfs, and perhaps photographs, without going so far, and he has just left for a trip to the interior for two months. Herr E. G. Dönnenberg, who has been for some years engaged in pushing German trade in Marocco, and every year visits the principal cities, says that a year ago he saw in Marocco city from half a dozen to a dozen dwarfs, one of whom was accompanied by a dwarf wife. They were about 4 ft. high, and robust and well made, and were certainly not Moors who had been dwarfed by rickets, as they differed from the ordinary population of Marocco in appearance. Herr Dönnenberg's address is Tangier, and he states that he is ready to answer any queries that may be sent to him, but that he cannot add anything to what is here stated, as he did not ask any questions as to the dwarfs, not knowing that they were of interest. He goes to Marocco city before long, and will make it a point to find out all he can respecting them.

DURING the latter part of last week a depression lay over the North Sea, which spread both in size and intensity, causing strong northerly winds all over this country, with heavy gales and snowfall in Scotland and the east of England, while in the southern districts the weather was fine and bright. The temperature was unusually low for the time of year, the mean temperature having in fact been considerably below the average on each day since the beginning of the month. The daily maxima have varied from 40° in the north to 52° in the south, with sharp frosts at night. On Sunday night the grass thermometer in London fell to 20°, while 25° in the shade were registered the next night in the north and west. During the early part of the present week, the area of high pressure in the west gave place to a depression, which arrived from off the Atlantic, causing cold easterly winds in the south with very heavy rains in the south-west of England; the weather over Scotland improved, although some snow showers continued to fall on the east coast. The *Weekly Weather Report*, issued on the 22nd instant, showed that the temperature of that week was much below the mean, the deficit ranging from 5° to 7°. Rainfall exceeded the mean in the east and north-east of England, but in all other districts there was a deficit. In the south-west of England there was still a deficit of about eight inches since the beginning of the year.

WE recently drew attention to a new meteorological journal published in Paris; we now note the appearance of a similar publication at Vilafranca del Panadés, in Spain. It is published on the 15th of each month, and contains a series of short elementary articles and notes, occupying only twelve small octavo pages. We hardly expect it to find many readers in this country, but hope it may awaken more interest in the subject in Spain, where practical meteorology is not at present on the same level as in other European countries.

THE Director of the Lyons Observatory, M. C. André, has published, under the title, "Relations des Phénomènes Météorologiques déduites de leurs Variations Diurnes et Annuelles," the results of the meteorological observations taken there for ten years ending 1890. The text and plates together occupy one hundred and sixty-eight large octavo pages, and, this volume will be found to be full of interest and instruction, to any one wishing either to take observations or to work up the results. The title is well chosen, for the work treats of the relations which connect the different phenomena; it also gives all necessary precautions for ensuring the accuracy of the observations. Particular attention is paid to the important subject of diurnal and annual variations of the different elements, and to the various points to be noted, while the different theories of atmospherical electricity are explained at considerable length.

A BEAUTIFUL and instructive lecture experiment, illustrative of the conditions of the heated atmosphere which give rise to the mirage, is described by MM. J. Macé de Lépinay and A. Perot, in their "Etude du Mirage," which appears in the *Annales de Chimie et de Physique*. Water is poured into a long rectangular trough with glass slides, and covered with a layer of alcohol about 2 cm. thick, containing a trace of fluorescene. After a few hours, during which the alcohol diffuses slowly through the water, a flat beam of light is sent through the mixture at a very slight inclination to the horizon. Under these conditions a kind of garland of light is seen to traverse the liquid, due to a series of curvilinear deflections or "mirages" in the less highly refractive water below and total reflections at the upper surface of the alcohol.

PROF. W. CROOKES and Prof. W. Odling, in their report on the London Water Supply for the month of September, are able to give an excellent account of the 182 samples which they analyzed. All were found to be perfectly clear, bright, and well filtered. In respect to the smallness of the proportion of organic matter present, the character of the water furnished by the seven companies continued to be entirely satisfactory, the mean amount of organic carbon in the Thames-derived supply, for example, being ·118 part, and the maximum amount in any single sample examined being but ·145 part, in 100,000 parts of the water—numbers practically identical with those of the previous month, or ·115 part for the mean, and 1·52 part for the maximum, amount. The average of the past six months, in the case of the Thames-derived supply, has amounted only to ·116 part of organic carbon in 100,000 parts of the water, with a maximum, twice met with, of ·152 part in any individual sample. The authors of the report do not expect that with the coming on of autumn and winter this low average will be much longer sustained. They note that the water supply to London is habitually at its best during the hot season, when a high quality of the supply is more especially called for.

AN interesting report on the Congress of the Library Association of Great Britain, held at Paris last month, was read on Tuesday before the Salford Royal Museum and Free Libraries' Committee. It was prepared by Mr. Alderman W. H. Bailey, who had naturally a good deal to say about the Paris Free Libraries. The governing bodies of almost all these institutions consider that there are many reasons why the libraries should be closed in the daytime when respectable artizans are engaged in earning their living. Books are therefore given out for two hours every evening of week days, generally from eight to ten o'clock, and also for two hours every Sunday morning. Mr. Bailey and the other members of the Congress were delighted with the Paris Libraries of Industrial Art, to which they devoted much attention. These Libraries—which, like the Free Libraries, are under municipal control—are in the artizan districts of Paris. Books, patterns, prints, drawings, and photographs are lent out. "Not only do house decorators," says Mr. Bailey, "find designs and books relating to work, but fan painters, porcelain modellers, designers of iron and bronze gates, medieval metal workers, cabinet makers, builders, and all workers in the constructive as well as the decorative arts may here find stimulus and draw inspiration from the wealth of examples on the shelves and walls." Free lectures are delivered in the winter on industrial art and science, and on the designs, books, and models in the Libraries.

VARIOUS experiments which are being made in France with a view to the improvement of the potato have attracted a good deal of attention in Australia. According to a statement recorded in the *Agricultural Gazette of New South Wales*, no fewer than 110 growers have obtained from a variety known as "Richter's Imperator," from twelve to twenty tons per acre, while the average is over fourteen tons to the acre. The Minister of Agriculture in New South Wales has approved of one hundredweight each of this and any other three sorts highly reputed in France being imported for experimental purposes.

AT a recent meeting of a society of French agriculturists, it was stated by Baron Bertrand-Geslin, that ten or twelve years ago a disease appeared among the chestnut trees in central and north-western France, and destroyed them in great numbers. The wood, moreover, could not be utilized for heating purposes. At this juncture an enterprising person appeared, who bought up large quantities of this dead wood and sent it by canal to Nantes, where he had works established for utilizing it in the tanning of leather. Chestnut wood contains, in fact, 5 to 6 per cent. of tannic principles, whereas oak contains only 3 or 4. By the means adopted in these works the principles are concentrated in a sirupy liquid of great strength. This establishment has become very important; it absorbs annually thirty to thirty-five million kilogrammes of wood of these dead chestnuts from three departments traversed by the canal from Nantes to Brest, and expends about 120,000 francs per annum, a considerable reduction of the loss sustained by the landowners. It was mentioned, however, by M. Paul Becquerel, in reply to a question as to competition of the new extracts with bark, that those extracts, which are products allied to tan, do not give the same results, or leather of such good quality, and many tanners who have used them have returned to the old methods of tanning.

DR. R. MUNRO contributed to the *Times* of Monday a long and most interesting account of the recent discovery of an ancient lake-village in Somersetshire. The site is about a mile north of Glastonbury. Before excavations were begun, there were sixty or seventy low mounds, rising from one to two feet above the surrounding soil and measuring from twenty to thirty feet across. That the mounds were of archæological interest was first suspected by Mr. Arthur Bulleid, who began to excavate some of them during the present summer, and was soon rewarded by making striking discoveries. Woodwork corresponding to that of the crannogs of Scotland and Ireland has been exposed, and among the objects which have been recovered are some of bronze, a few of iron, and various specimens of pottery. Mr. Bulleid has also dug out "a splendid canoe neatly formed out of the trunk of a tree." This was found about a quarter of a mile from the settlement. It would seem that the inhabitants, after a period of long occupancy, indicated by a succession of superimposed hearths, were flooded out of their homes, for an accumulation of flood soil now covers the whole meadow to the extent of 12 inches to 18 inches in depth. The surrounding district is richly cultivated, but, in looking over an old map of the date of 1668, Dr. Munro found that it contained a lake called the "Meare Poole," into which three streams debouched, and from which the site of the present discovery could not be far distant. He suggests that this lake had larger dimensions in earlier times, and that when the settlement was founded the locality was a shallow lake or marsh. The old map represents the district lying immediately on the north-west borders of the "Meare Poole" as inhabited by the Belgæ. Dr. Munro is strongly inclined to think that the settlement belongs to the so-called Late Celtic period. This he would simply call the Celtic period, for there is no evidence, he believes, of earlier Celtic remains in Britain than those known as Late Celtic. "The style of art," he says, "which controlled the manufacture of Late Celtic objects involves such an enormous advance in metallurgical skill over that of the Bronze Age, that it is impossible to suppose the two are connected by any evolutionary stages in this country. From the standpoint of archæological research this interval, or rather *hiatus*, can only be bridged over by the supposition that the people who owned Late Celtic remains were newcomers and conquerors in Britain." Much light will no doubt be thrown on the question by the further exploration of these remarkable mounds.

A LIVELY correspondence on the subject of birds *versus* insects has been going on in the Malta papers. According to the *Mediterranean Naturalist*, the enormous increase of insectiferous pests during the last few years has caused the agricultural industries to decline to an alarming extent, and it is urged that the evil has now increased so much as to call for legislation. In the Maltese Islands there are no laws for the protection of birds, and, the lower classes of the Maltese being keen sportsmen, no opportunities are allowed to either the migratory or the indigenous species of increasing.

IT was observed by Prof. Voit that when dogs were fed exclusively on bread they daily lost albumen, though not weight; the body becoming more watery and the hæmoglobin of the blood diminishing. This matter has been recently further investigated in his laboratory by Herr Tsuboi. Of three rabbits, one was fed with milk, rolls, and some hay; another with much hay; the third with potatoes. The last had more water in muscles and blood, and less hæmoglobin than the first. In another experiment (with like results) one of two cats was fed with meal and fat, another with bread and some meat extract. Again, three rabbits were fed with potatoes, the first with iron added, the second with serum, the third with blood. The last was found to have most solid matters in muscles and blood, and most hæmoglobin. It is not (the author points out) the amount of food by itself alone that determines the result, otherwise, in the fasting state, the hæmoglobin would be least, whereas it is the same as with good feeding. It is rather the insufficient composition of the food, the too small amount of albumen, with excess of starch-flour that has the injurious effect.

THE phosphoroscope of Becquerel is a well-known instrument, enabling one to observe the phosphorescence of some substance when the exciting light is gone. It is designed to be used with sunlight. M. Lenard has devised an instrument (*La Nature*) for use with the electric spark. To the armature of a Foucault interrupter in an induction coil, is attached a light wooden rod, having at its end a piece of blackened pasteboard, which is thus driven up and down before a spark-interval between two brass knobs connected with the coil and a condenser (added to intensify the spark). The body to be examined is placed close behind the interval, so that it is uncovered very quickly after the spark passes. Some curious phenomena are observed. The short duration of the spark makes the screen seem at rest, and some thousandths of a second after one sees a luminous body behind where it was; so that at first sight one might think the screen opaque to the spark, but transparent for the phosphorescent light, an illusion due to the persistence of luminous impressions. Some bodies, such as various carbonates of lime, behave very much alike in this apparatus and in Becquerel's; some are favoured in the latter, and on the other hand, crystals of arragonite, which are invisible after solar illumination, give a faint reddish light after the spark. Various experiments are described. The most curious results are furnished by the remarkable substance, asaron. In a Crookes tube this gives a bright light, it gives also a distinct glow in the ultraviolet spectrum of the spark; but in the phosphoroscope it is absolutely dark. The vibratory movement ceases immediately with the excitation.

THE new number of the *Internationales Archiv für Ethnographie* (Band v., Heft 4) consists mainly of the first part of what promises to be an elaborate paper (in German) on the inhabitants of the Nicobar Islands, by Dr. W. Svoboda. In October, 1886, while the German corvette, *Aurora*, lay in the harbour of Nangcauri, Dr. Svoboda had many opportunities of seeing the natives, and Mr. E. H. Man gave him facilities for the thorough study of a splendid collection of ethnographical objects from various parts of the group. Afterwards he extended his knowledge of the subject by reading books which dealt with it, and by visiting the ethnographical museums of Berlin and Vienna. The results he is now bringing together, and those of them embodied in the present contribution show that he is not only a good observer but that he knows how to state facts clearly and concisely. The paper is illustrated with coloured plates and woodcuts.

THE British Institute of Public Health has now an official quarterly journal, called *The Journal of State Medicine.* It is published by Charles Griffin and Co. The second number has appeared, and contains original papers on the following subjects:—lead in articles of food, by Prof. William R. Smith; points in the ætiology of typhoid fever, by Edmond J. McWeeney; chemical bacteriology of sewage, by W. E. Adeney; and new method of sewage purification, by W. Kaye Parry.

A NEW and revised edition of the late Prof. Moseley's well-known "Notes by a Naturalist on H.M.S. *Challenger*," has been issued by Mr. John Murray. It includes an excellent portrait, which vividly reminds us of the great loss inflicted on science by his premature death.

MESSRS. WHITTAKER AND CO. have published the first part of a work entitled "Dissections Illustrated: A Graphic Handbook for Students of Human Anatomy," by C. Gordon Brodie. The plates are drawn and lithographed by Percy Highley. The work will be completed in four parts. The present part deals with the upper limb, and includes seventeen coloured plates.

A SECOND edition of "A Short Manual of Inorganic Chemistry," by Dr. A. Dupré and Dr. H. W. Hake (Charles Griffin and Co.), has been issued. The authors have endeavoured to bring the statement of facts up to date without increasing the bulk of the work, and to remove those errors to which their attention has been drawn.

A RE-DETERMINATION of the mechanical equivalent of heat has been made by M. C. Miculescu at the Sorbonne. An account of the method appears in the *Annales de Chimie et de Physique* for October. The method was that of water friction at constant temperature. The liquid was enclosed in a cylindrical vessel with three envelopes. Water was kept circulating round the innermost one at such a rate that the difference of temperature of the water at entrance and exit was constant as measured by a thermopile. The heat thus derived from the water inside could be estimated by the quantity of water passed through. The water inside was stirred by vanes mounted on an axial shaft kept rotating by a gramme machine of 1 horse-power running at 1200 revolutions per minute. The expenditure of work was measured by making the whole apparatus its own dynamometer. It was suspended so as to turn round the common axis of the stirrer and the motor. The resistance met with by the former tended to turn the apparatus in the direction of revolution of the latter. It was kept stationary by a weight attached to an arm exerting a measurable couple. The mean of 31 values ranging from 426·21 to 427·12 was 426·70 in kilogram-metres per calorie, or 4·1857 × 10^7 ergs. For the normal scale of the hydrogen thermometer this would be 426·84.

A NEW and very convenient method of preparing acetylene gas is described by M. Maquenne in the current number of the *Comptes Rendus*. A short time ago the same chemist succeeded in preparing a comparatively stable compound of carbon with the metal barium, BaC_2, by heating powdered retort-charcoal with barium amalgam in a current of hydrogen. Upon bringing this compound in contact with water a violent action was found to occur with evolution of almost pure acetylene gas. On account, however, of the troublesome nature of the operations of procuring barium amalgam and preparing from it the new compound, together with the very small quantities of the latter eventually obtained, this mode of preparing acetylene was only of theoretical interest, and not suitable as a laboratory method of preparation. M. Maquenne now describes a new process for preparing barium carbide, by means of which large quantities may very readily be procured in a few minutes, and from which correspondingly large volumes of acetylene may be derived. The principle of the method consists in reducing barium carbonate by metallic magnesium in presence of carbon. An intimate mixture is first made of barium carbonate prepared by precipitation, powdered metallic magnesium, and calcined retort-carbon. Convenient amounts are twenty-six grams of barium carbonate, ten and a half grams of magnesium, and four grams of charcoal. This mixture is then introduced into an iron bottle of about seven hundred cubic centimetres capacity, furnished with a tube, also of iron, thirty centimetres long and two centimetres internal diameter. The iron bottle is then heated in a gas furnace which has previously been raised to a red heat. At the expiration of about four minutes an energetic reaction occurs, accompanied by the projection of brilliant sparks from the mouth of the tube. The apparatus should then at once be removed from the furnace, the end of the tube stopped, and the bottle and contents rapidly cooled by the external application of cold water. The product may then be extracted, when it is found to consist of a mixture of magnesia with 38 per cent. of carbide of barium, a little excess of carbon, and a trace of cyanide formed at the expense of the atmospheric nitrogen. The reaction accords very closely with the equation :—

$$BaCO_3 + 3Mg + C = BaC_2 + 3MgO.$$

Carbide of barium may be preserved for an indefinite time in a dry atmosphere. It is a grey, porous, and very friable substance. When heated to redness in the air it burns with a vivid incandescence. It is also capable of combustion in chlorine, hydrochloric acid gas, and vapour of sulphur. In order to prepare acetylene from it the powder is most conveniently placed in a small flask fitted with a doubly-bored caoutchouc stopper, carrying a dropping funnel containing water, and a delivery tube. The moment water is allowed to drop the equivalent quantity of acetylene gas is evolved in accordance with the equation :—

$$BaC_2 + 2H_2O = Ba(OH)_2 + C_2H_2.$$

The delivery of the acetylene may be regulated with great nicety by suitable adjustment of the stopcock of the dropping funnel. The acetylene thus prepared possesses the further advantage of being remarkably pure, containing 98 per cent. of C_2H_2. It is interesting to learn that by allowing a stream of this pure acetylene to pass through a long heated glass tube for a few hours several grams of synthetical benzene have been accumulated by M. Maquenne.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mr. W. F. Faulding; a Buffon's Touracou (*Corythaix buffoni*) from West Africa, presented by Mr. A. L. Jones; two Double-banded Sand Grouse (*Pterocles bicinctus* ♂ ♀) from Senegal, presented by Mr. H. H. Sharland, F.Z.S.; a Gannet (*Sula bassana*), British, presented by Dr. Davis; a Roseate Cockatoo (*Cacatua roseicapilla*), a King Parrakeet (*Aprosmictus scapulatus* ♀) from Australia, presented by Mrs. Addiscott; four Alligators (*Alligator mississippiensis*) from the Mississippi, presented by Mr. John Terry; two Thick-billed Seed-eaters (*Oryzoborus crassirostris*), a Tropical Seed Finch (*Oryzoborus torridus*), a Saffron Finch (*Sycalis flaveola*), a Bluish Finch (*Spermophila cærulescens*) from South America, a Puff Adder (*Vipera arietans*) from West Africa, deposited.

OUR ASTRONOMICAL COLUMN.

COMET BARNARD (OCTOBER 12).—An *Astronomische Nachrichten* circular note gives the following elements and ephemeris, computed from observations made on the 16th, 17th, and 18th of this month :—

Elements.

T = 1892 Nov. 12·745 Berlin M.T.

ω = 168° 49′
☊ = 220 50
i = 21 39
log. q = 0·03669

Ephemeris Berlin Midnight.

1892.	R.A. h. m.		Decl. ° ′		Log Δ.		Br.
Oct. 25 ...	20 6·6	...	+7 47				
27 ...	13·5	...	6 51	...	9·6825	...	1·46
29 ...	21·5	...	5 52				
31 ...	29·8	...	4 51	...	9·6609	...	1·66
Nov. 2 ...	38·7	...	3 47				
4 ...	48·2	...	2 40	...	9·6377	...	1·87
6 ...	20 58·3	...	1 29				

As the brightness at the time of discovery is taken as unity, it will be noticed that the comet is quickly gaining in intensity, the value for November 8 being 2·08 Br. Its position on the 31st lies in the southernmost part of the constellation of the Dolphin, forming very nearly an equilateral triangle with α Aquilæ and β Delphini.

DISCOVERY OF THREE NEW PLANETS BY PHOTOGRAPHY.—M. Perrotin has communicated to the French Academy an account of the discovery of three small planets by M. Charlois, of the Nice Observatory, by the aid of photography. The apparatus employed consisted of an Hermagis portrait lens of 15 cm. aperture and 80 cm. focal length, mounted provisionally on M. Loewy's *equatorial coudé*. The instrument was being employed for the photography of the region of the ecliptic. With exposures ranging from two hours and a half to three hours, the eight negatives obtained since September 12 cover a region 80° long and 10° broad, and show all the stars visible through the 38 cm. refractor. A careful examination of the plates reveals the presence of three unknown and eight known planets. The former, now known under the names 1892, D, E, and F, are all of about the twelfth magnitude.

RUTHERFURD MEASURES OF STARS ABOUT β CYGNI.—Mr. Harold Jacoby, in No. 4 of the *Contributions from the Observatory of Columbia College, New York*, presents us with the reduced results of the measures of the plates containing the group of stars surrounding β Cygni. The method of measurement was exactly the same as that employed in the case of the Pleiades plates, but that of reduction has received some slight modification. For instance, the measures of the eastern and western impressions have not been separately dealt with, but their mean has been taken, and the reduction continued, using this mean as a single observation. As the accuracy of these measurements depend on the exactitude of the scale value determinations to a very considerable extent, it is satisfactory to hear that this value has remained materially the same for a very long period. The largest and smallest values recorded in the Pleiades plates were 28″·0167 and 28″·0066, the mean value amounting to 28″·0124, and it is his last-mentioned value that has been used in the above reductions. The probable error of these determinations is then ±0″·00071, which corresponds to ±0″·025 per 1000″. But Mr. Jacoby does not think that the average uncertainty of the final places exceeds 0″·15 on account of scale value. While comparing the Rutherfurd stars with those of Argelander, he found that four stars from the latter were lacking, while they were recorded on the original negatives of the former. Observations made this year showed that three were visible, while the fourth (No. 28), which was quite close to No. 27 on the Rutherfurd negatives, was this year "only a sort of elongation of No. 27." On the other hand, the following of Argelander's stars were absent from the plates :—

B.D.	+ 27·3395	Mag.	8·8
	+ 27·3414	,,	9·0
	+ 27·3417	,,	9·0

and perhaps

	+ 27·3435	,,	8·5
	+ 28·3343	,,	9·0

A New Variable Star.—In *Astronomische Nachrichten*, No. 3124, Prof. Pickering announces the discovery of a new variable star in Aries by Prof. Schaeberle. The fact of this star being a variable was first noted when, on an examination of two plates taken December 18 and January 24, 1891, it was found that on the former it appeared of the 9·5 magnitude, while on the latter it was absent altogether. Recent visual observations have shown, however, a star of the eleventh magnitude in the exact position of the suspected variable, and this has been confirmed by means of photographs. From photographs of the same region, taken since October 31, 1890, the magnitudes recorded have been 9·6, 10·2, 11·0, less than 11·7, 10·1, 10·0, 10·4, 10·3, and 10·9. The star's position for 1900 is given as

R.A. 3h. 5·5m. Decl. + 14°24′.

Jupiter's Fifth Satellite.—It hardly ever happens that, after a discovery of any importance has been made, there are not a few "claimants" who wish to annex it as their own. This is the case with Prof. Barnard's discovery of the fifth moon to Jupiter, but the advantage he possesses over these said "claimants" is, we might say, infinite, for it is only with such an instrument as that at the Lick Observatory that this "mite" of a satellite can be observed with success. One of the despatches in which one "claimant's" views were put forth, had the audacity to insinuate that Prof. Barnard was directly inspired to this discovery by information contained in a letter sent to the Observatory. We are glad to see that Prof. Barnard deals with these "claimants" as they deserve, and we hope it may be a lesson to others who wish to assert their priority without good and sufficient reasons for doing so.

As an illustration of the difficulty of observing this satellite, we may mention that Prof. Young, in a letter to Prof. Barnard, says that although he has used a 23-inch Clark, which is an instrument as nearly perfect as can be made, he was not rewarded with success.

The Spectrum of Nova Aurigæ.—Herr E. von Gothard, of the Observatory at Herény, has taken a very successful photograph of the Nova spectrum, the results of which he communicates to *Astronomische Nachrichten*, No. 3122. The instrument used was a 10½-inch reflector with a 10-inch objective prism, and the exposure given amounted to 45 minutes. The spectrum shows six lines, and a comparison with the spectrum of the ring nebula and the Wolf-Rayet stars presented a remarkable concordance, the first failing only in the second Nova line, and the second differing only with regard to the intensity of the individual lines. The following table shows this somewhat more clearly :—

	I.	II.	III.	IV.	V.	VI.	VII.
Nova ...	6	1	10	5	3	4	—
G. C. 4964	8	2	10	6	6	8	—
Ring nebula	8	—	5	2	7	6	10

The wave-lengths of the lines are, we are sorry to say, not inserted.

"Jupiter and His System" is the title of a small book recently published by Mr. Stanford, and written by Miss E. M. Clarke. The authoress has brought this book out at a time when this planet is receiving most attention, for was it not in opposition, shining with exceeding brightness, on the 12th of this month? One great point about this little monograph is that facts throughout have been strictly adhered to, so that the reader is presented with the true state of the planet as we know it. The information is well up to date, as for example the mention of the new satellite, and the book is written in a popular yet accurate style. One thing that calls for attention is the price (one shilling), which could doubtless have been halved.

GEOGRAPHICAL NOTES.

Mr. J. Y. Buchanan, F.R.S., is this term delivering a course of lectures on Oceanography in Cambridge University. It is satisfactory to know that the lectures are better attended than has been the case since the foundation of the Geography lectureship, and that the greater number of those present this term are undergraduates.

Mr. Joseph Thomson has submitted to the British South Africa Company the report of his journey to the Lake Bangweola region, made last year, which ill-health has prevented him from preparing sooner. He speaks of Northern Zambesia generally as a region of great possibilities. It is a plateau rarely less than 3500 feet high, with a climate in which Europeans should find no difficulty in living for several years at a time. It is well suited for cattle-rearing and for planting, and there is an appearance of mineral wealth. Like the rest of tropical Africa, the land must be occupied and cultivated, and the natives must be trained to industry before commercial results of any importance can be obtained.

The special meeting of the Royal Geographical Society to hear Captain Lugard's paper on Uganda will be held on Thursday, Nov. 3, at 8.30 p.m. On account of the great popular interest at present being manifested in the region of the Equatorial lakes, no extra tickets can be issued by the Society, as the attendance of Fellows and their friends will probably more than fill the hall.

The new number of *Petermann's Mitteilungen* contains some articles of considerable interest. Dr. W. Ruge, son of the well-known geographer, Dr. Sophus Ruge, contributes a short but learned treatise on the geography of Asia Minor, which combines literary research with personal exploration. Dr. Ernst H. L. Krause produces an interesting map of North Germany, showing the distribution of forests and the most common species of trees during the Middle Ages. This work is accomplished mainly by the consultation of old records, and the examination of the remains of old forests and very ancient trees. The study of history is greatly helped by such a map, and the influence of increasing density of population and extending cultivation of farm crops is brought out strikingly by comparison with a map of the vegetation at the present day. Dr. Karl Sapper's description of Lake Yzabal in Guatemala is also worthy of note.

GEIKIELITE AND BADDELEYITE, TWO NEW MINERAL SPECIES.

Various pebbles were lately brought to this country by Mr. Joseph Baddeley, who has been acting as manager of a Gem and Mining Company in Ceylon. They had been picked up by him in the neighbourhood of Rakwana (Rackwanné) at various times, and had then attracted his special attention by reason of their high specific gravity. Their real nature not being evident on inspection, Mr. Baddeley, when invalided, brought them home to England for identification.

One kind of pebble, kindly analyzed for him by Mr. Claudet, was found to be essentially a tantalate of yttrium.

Pebbles of another kind were taken to the Museum of Practical Geology in Jermyn Street for examination. The external characters being found by Mr. Pringle insufficient for the determination of the species, the pebbles were handed over to Mr. Allan Dick for chemical investigation. Quantitative analysis proved the mineral to be essentially magnesium titanate ($MgTiO_3$) and chemically analogous to Perofskite, calcium titanate ($CaTiO_3$). To this interesting new species Mr. Dick, in a paper read before the Mineralogical Society in June, gave the name Geikielite, in honour of Sir Archibald Geikie, F.R.S., Director-General of the Geological Survey, in whose laboratory the analysis had been made.

As described by Mr. Dick, Geikielite has a specific gravity

3·98: its hardness (6·5) is between that of quartz and felspar. It has a perfect cleavage, with a splendent metallic lustre, and an imperfect cleavage nearly at right angles to the former. The pebbles themselves show no remains of crystal-faces, are bluish-black in colour, and opaque; but thin cleavage-flakes, when seen in the microscope, have a peculiar purplish red tint, and in convergent polarized light show a uniaxal figure, of which the axis is just outside the field of vision. When digested with hot strong hydrochloric acid the finely powdered mineral is slowly decomposed, and the titanic acid separates out. In strong hydrofluoric acid complete solution takes place in a few hours. The mineral is infusible with the blowpipe: fused with microcosmic salt it gives the characteristic reaction of titanic acid, notwithstanding the presence of a small proportion of oxide of iron.

Shortly after Mr. Dick's paper had been read, Mr. Baddeley courteously offered to allow me to select a single pebble for the British Museum Collection out of his small store of the mineral, the remaining ones being required by him for sending as samples to be used by searchers in Ceylon. But this store, small though it was, consisted of more than one kind of pebble, the close similarity of aspect being due to friction against a bit of graphite which was with them. On this heterogeneity being pointed out, Mr. Baddeley allowed me to take not only the promised pebble of Geikielite, but also those three pebbles which, not being Geikielite, were useless as samples of that mineral. One of the three fragments proved to be garnet, a second was ilmenite—both of them common minerals—but the third, a fragment of a crystal still retaining some of its faces, presented characters which give it unusual interest.

The fragment, which weighs just over three grams, is black and opaque, and has the general aspect of columbite; its extremely high specific gravity (6·02) and its hardness (6·5) are also suggestive of that mineral. In microscopic fragments it transmits light and is dichroic, changing from a greenish yellow to brown with the plane of polarization of the light; the fragments, when examined in convergent polarized light, show a biaxal figure, the apparent axial angle being large (near 70°); the character of the double refraction is negative. There is only one well-developed zone of crystal-faces remaining on the fragment; it consists of two rectangular pairs of parallel faces (pinakoids) and of four prism faces (*m*), the faces of one pinakoid (*a*) being much larger than those of the other (*b*); the angle *am*, as determined by means of reflection, is about 44°, but the images of the signal are multiple and wanting in definition; the dispersion of the optic axes indicates that the system of crystallization is mono-symmetric. Two other faces form a re-entrant edge parallel to the larger pinakoid, and inclined to the edges of the well-developed zone, but whether this is really due to twinning or not is far from evident.

The above set of external characters suggested that the fragment does not belong to any of the known species, and it became necessary to determine its chemical behaviour, but on account of the necessity of preserving the natural faces of what might possibly be an unique fragment, this was a process demanding great caution; fortunately, the behaviour was such that it was practicable to determine the precise chemical nature of the mineral without interference with the crystal faces, or, indeed, any appreciable destruction of material. It will be sufficient to state here the result, namely, that the material is no other than crystallized zirconia; the technical details relative to both this mineral and Geikielite will be given in the next number of the *Mineralogical Magazine*. It is remarkable that, notwithstanding the wide prevalence of zircon itself (silicate of zirconium), the natural occurrence of the oxide of zirconium has not previously been noticed. For this new species I beg to suggest the name Baddeleyite, in recognition of the services of Mr. Baddeley to mineralogical science; but for his close scrutiny of the mineral products of Rakwana, the existence of the above remarkable species would doubtless have long remained unknown.

L. FLETCHER.

NEW BRITISH EARTHWORMS.

THE additions which I have been able to make to our list of indigenous Annelids during the past two years fall naturally into two groups. There are, first, two species which are new to science, and are therefore at present known only as British species. In addition to these there are several species which, while they have been recorded for various Continental stations, have never been found in England till I discovered them among the gleanings which I have passed under review from nearly every part of the country. I shall first of all give a description of the new species.

I. *Lumbricus rubescens*, sp. nov.

This is a genuine Lumbricus in the strictest sense of the word, as it is understood by all those who adopt Eisen's analysis of this group of worms published in 1873. The lip forms a perfect "mortise and tenon," with the first ring or peristomium, and the girdle consists of six segments, four of which bear the *tubercula pubertatis*. I first discovered it in Yorkshire in 1891, and have since then taken it myself at Hornsey in Middlesex, Tunbridge Wells, and Dallington in Sussex, while more recently I have received it from Avonmouth in Gloucestershire.

In general appearance it resembles the common earthworm (*L. terrestris*, L.), as recently defined and differentiated. It is slightly smaller in size, but frequents similar haunts, and might in most respects easily be mistaken for the type. It has the male pores on segment 15 on raised, pale papillæ; but the girdle invariably commences on segment 34, and extends to the 39th, while the band which forms the *tubercula pubertatis* extends over 35 to 38. Its general form and appearance will be best understoood by the study of the woodcut (Fig. 1). Internally it does not differ from the other Lumbrici, but the dorsal pores commence between $\frac{5}{6}$. This makes the fourth true Lumbricus found in the British Isles, and it may be a convenience to collectors if I append a tabular statement of the features by which each is distinguished from the other.

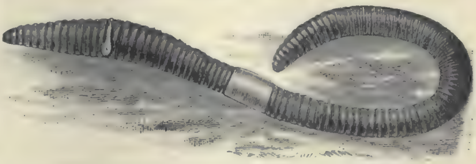

FIG. 1.—*Lumbricus rubescens*, Friend. Natural size.

Chart of the Genus Lumbricus.

Lumbricus	Segments occupied by the					Average length.	No. of segments.
	Girdle.	Tubercula.	First dorsal pore.	Papillæ.	Spermatophores		
Terrestris, Linn...	32—37	33—36	$\frac{8}{9}$	15, 26	? [1]	5 inches	150—200
Rubescens, Friend	34—39	35—38	$\frac{5}{6}$	15, 28	32/33	4 inches	120—150
Rubellus, Hoffm.	27—32	28—31	$\frac{7}{8}$	none	?	3 inches	110—140
Purpureus, Eisen	28—33	29—32	$\frac{6}{7}$	10 (11)	? [1]	2 inches	100—120

It will be seen that there is now a regular series in relation to the first dorsal pore, $\frac{5}{6}$, $\frac{6}{7}$, $\frac{7}{8}$, $\frac{8}{9}$, as well as in the matter of length from 2 to 5 inches and upwards, and number of segments from 100 to 200 or thereabouts. These points are worthy of note in the study of the evolution of worms.

2. *Allolobophora cambrica*, sp. nov.

This species, which I have since found in several parts of England, first came to my notice as a new species from Wales. Hence the specific name. I had previously assigned it to one or other of the related species, but eventually found on dissection that it was quite distinct from every other worm of which I have been able to obtain any description.

At first sight *A. cambrica* has all the appearance of the mucous worm (*A. mucosa*, Eisen). Its average length in spirits is about 2 inches, but when living, and moderately extended, it measures three inches. It is of a fleshy colour, with a somewhat transparent skin, so that the blood-vessels can be well observed between the girdle and the head. The dorsal pores are conspicuous in specimens which have been placed in methylated spirits, the first occurring between segments 4 and 5. The

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[1] Vejdovsky and others mention the occurrence of Spermatophores on these species, but do not state the position. The point is one which should not be ignored.

setæ are in four couples, the individuals of which are near each other. The girdle covers segments 29 to 37, while 31 : 33 : 35 bear each a pair of tubercules (Fig. 2) as in the green worm (*A. chlorotica*). There are two pairs of spermathecæ in segments 10 and 11, opening anteriorly; the male pore on segment 15 is borne on prominent papillæ, which cause the adjoining segments to appear swollen (Fig. 3). It is a very clean worm, exudes but little mucus as compared with the green worm; the tail is much longer than in that species, which, in the matter of girdle and tubercules, it most nearly resembles. It will be well to tabulate the points in which this worm resembles and differs from its nearest allies.

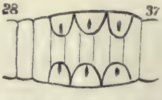

FIG. 2.—Diagram of girdle of *A. cambrica*, Friend, showing tubercula on ventral surface.

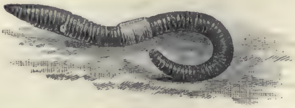

FIG. 3.—*Allolobophora cambrica*, Friend. Natural size.

Allolobophora cambrica resembles

Allo. chlorotica	*Allo. mucosa*
in position and appearance of male pore, girdle, and *tubercula pubertatis*.	in colour, shape, size, activity, position of first dorsal pore, and appearance of male pore.

It differs

in mucus, transparency, length and shape of tail, and number of spermathecæ.	in position and shape of girdle, position of *tubercula pubertatis*, and general outline.

Tabular View.

Allolobophora	Segments occupied by the				General observations.
	Girdle.	Tubercula.	First dorsal pore.	Spermathecæ.	
Chlorotica	29—36	31 : 33 : 35	$\frac{4}{5}$	9 : 10 : 11	Dirty green, opaque, sluggish, and grub-like, exudes much mucus
Mucosa .	26—32	29 : 30 : 31	$\frac{4}{5}$	10 : 11	Flesh-coloured, active, with transparent epidermis, little mucus
Cambrica	29—37	31 : 33 : 35	$\frac{4}{5}$	10 : 11	Closely resembling *A. mucosa* in general features

When our knowledge of the hybridity of worms is more perfect, it is possible that some new light will be thrown upon such coincidences as these. I have received the worm from, or collected it in, Nottinghamshire, Hertfordshire, Yorkshire, and Montgomeryshire. I believe I have also found it in Westmorland and elsewhere, but entered it either under one or the other of the two species which it so closely resembles.

Next, we have to note the worms which are new to Britain, though not new to science. These all fall under the genus Allolobophora, and several of them are so well marked that I have, in some recent articles on this subject, revived Eisen's subgeneric term Dendrobæna, and placed under it about half-a-dozen species of tree-worms which are more or less widely distributed in this country.

The tree-worms are small, hardy, and active; the lip is usually very delicate, and appears to be used, not only as a sucker and boring agent, but also as a tissue dissolver, probably by the use of a special saliva. The setæ are usually in eight almost equidistant rows, and the lip cuts more or less deeply into the first ring. The type of this group is *Dendrobæna Boeckii*, Eisen, which has been the subject of endless confusion. The true species, following the diagnosis of Eisen, is very rare in England, and I have found it nowhere but in Airedale and Wharfdale, Yorkshire. I believe all the other records which have been given by other writers should be assigned to the much more common and widely distributed species known as *Allolobophora subrubicunda*, Eisen. This worm belongs to the same group, but lives among vegetable *débris*, as well as beneath the bark of decaying trees. Another species (*A. arborea*, Eisen) is found only in dead timber. I have specimens from Cumberland, Gloucestershire, Yorks, and Sussex. It is one of the prettiest and neatest worms indigenous to this country. Nearly related to this is another (*A. celtica*, Rosa), which, while it prefers trees, will thrive among decaying vegetable matter. I first found it at Langholm, N.B., some two years ago, but since then I have taken it plentifully in Carlisle, Morecambe, and Tunbridge Wells, besides receiving it from Sussex, Devonshire, Gloucestershire, Northants, and elsewhere. It bears spermatophores during the spring months.

When I was in the south of England in the early months of this year, I discovered a couple of specimens of a new British tree-worm (*A. constricta*, Rosa). This species seems to me to belong to the south, just as *D. Boeckii* belongs to the north. I am making notes on the distribution of these species in order if possible to ascertain their limits. A very anomalous worm (*Lumbricus Eiseni*, Levinsen) belongs to this group, though it has certain Lumbricus affinities. It is far from being a true Lumbricus, since it possesses neither *tubercula pubertatis* nor spermathecæ. Its girdle, too, is abnormal, for, whereas in the genuine Lumbricus the girdle invariably covers six segments, in this worm it extends over eight or nine. At present it does not fit in to any known genus, and should probably be made the type of a new genus. I have found it in Carlisle, Gloucestershire, and Sussex. Rosa has obtained it in Italy, and Levinsen in Copenhagen; so that it appears to be very widely distributed. On the Continent one or two further species belonging to this group are on record. On account of their habits, size, and affinities I place them in the subgenus Dendrobæna, which may be presented in tabular form as follows:—

Tabular View of Subgenus Dendrobæna.

Dendrobæna	Segments occupied by the			Setæ.	Prostomium.	Colour.
	Girdle.	Tubercula.	First dorsal pore.			
Boeckii, Eisen ...	29—33	31 : 32 : 33	—	8 equidistant	Cuts $\frac{3}{4}$ peristomium	Dark brown
Subrubicunda, Eis.	26—31	28 : 29 : 30	$\frac{5}{6}$	4 wide pairs	Cuts one half	Rose red, fleshy
Arborea, Eisen ...	27—31	29 : 30	$\frac{5}{6}$	4 wide pairs	Cuts one half	Red brown, iridescent
Eiseni, Levinsen...	24—32	0	$\frac{5}{6}$	4 close pairs	Cuts the whole	Violaceous, iridescent
Constricta, Rosa...	26—31	0	$\frac{5}{6}$	4 pairs	Cuts one half	Rose red, fleshy
Celtica, Rosa ...	30—36	33 : 34	—	4 wide pairs	Cuts one half	Violaceous, ruddy

Another group of worms belonging to the genus Allolobophora, with features more or less similar to those of the typical earthworm, has recently been enlarged by the addition of two or three species. The first (*A. profuga*, Rosa) seems to be generally distributed throughout England, as I have received it from several localities. Its synonymy, however, is at present somewhat uncertain. The long worm (*A. longa*, Ude) is the most ubiquitous of all our native species, and has for years past been confused with the common earthworm. The other species must for the present be entered as *A. complanata* (Dugès). The Continental authorities differ in their judgment respecting the identity and synonymy of this worm, and I have hitherto been unable to disentangle the complications. Certain it is that we have a species which corresponds in part with the worm described imperfectly by Dugès, and I hope in a little time to be able to determine its exact relationships.

I append a list of all those species of British earthworms which I have personally collected, examined, and identified; in each instance referring to the original memoir, and collating the worm with the author's description.

A List of Known British Earthworms.

	Author.	Date.	Memoir.
LUMBRICUS.			
1. Terrestris	Linnæus	1758	"Syst. Nat.," ed. x., tom. i., 647.
2 Rubellus	Hoffmeister	1845	"Familie der Regenwürmer."
3. Purpureus	Eisen	1870	*Öfversigt af K. Vet.-Akad.*
4. Rubescens	Friend	1891	Linnean Society, 1892.
ALLOLOBOPHORA.			
§ 1. Lumbricoidea.			
5. Longa	Ude	1886	*Zeitschrift f. Wiss. Zool.*
6. Profuga	Rosa	1884	"I Lumbricidi del Piemonte."
7. Complanata... ...	Dugès	1837	*Ann. des Sc. Nat.*, 2nd ser., viii.
§ 2. Mucida.			
8. Chlorotica	Savigny	1826	Cuv., "Hist. des. Prog. Sc. Nat.," ii.
9. Trapezoidea... ...	Dugès	1837	*Ann. des Sc. Nat.*, 2nd ser., viii.
10. Turgida	Eisen	1873	*Öfversigt af K. Vet.-Akad.*
11. Fœtida	Savigny	1828	Cuv., "Hist. Pr. Sc. Nat.," tom. iv.
12. Mucosa	Eisen	1873	*Öfversigt af K. Vet.-Akad.*
13. Cambrica	Friend	1892	NATURE, current issue.
§ 3. Dendrobæna.			
14. Boeckii	Eisen	1873	*Öfversigt af K. Vet.-Akad.*
15. Subrubicunda ...	Eisen	1873	" " "
16. Arborea	Eisen	1873	" " "
17. Eiseni	Levinsen	1883	"Syst. Geogr. Overs. over de Nord. An."
18. Constricta	Rosa	1884	"I Lumbricidi del Piemonte."
19. Celtica	Rosa	1886	*Bolletino dei Musei di Zoo. ed Anat.*
ALLURUS.			
20. Tetraedrus	Savigny	1828	Cuvier, "Hist. des. Prog.," tom. iv., p. 17.
21. Luteus	Eisen	1870	*Öfversigt af K. Vet.-Akad.*

When Darwin wrote his work on "Vegetable Mould," he assumed the existence of eight or ten species of earthworm in Great Britain. We now find a score of well-defined species, to which I have no doubt we shall be able to add a few others when the montane and out-of-the-way habitats have been explored. I shall be happy to receive consignments of living worms from any part of the kingdom, packed in tin boxes lightly filled with soft moss, and addressed The Grove, Idle, Bradford.

HILDERIC FRIEND.

THE PROBLEM OF MARINE BIOLOGY.[1]

IN common with the other branches of biological science, the study of marine life has made wonderful advances in the past half century, and we now begin to get a proper conception of the vastness and importance of this realm of nature.

The study of marine life has been compassed by serious difficulties; on shipboard it is impossible to examine in the living condition the enormous quantity and endless variety of forms brought up at a single haul of the net or dredge; and the old method of merely dropping the specimens into vials of alcohol resulted in vials of wrath to the naturalist who later studied the creatures in hopes of gaining from the distorted relics some knowledge of the normal appearance and anatomy. Now all this is changed, and by aid of certain chemical reagents most animals can be killed and preserved in a manner very satisfactory for study of their gross and microscopical anatomy, and hence the material collected can be examined at leisure in permanent laboratories with results corresponding to the better facilities. There has, too, been a great lack of suitable and accurate collecting apparatus. The early method was to scoop up a quantity of sea water and then tediously examine it in small quantities under the microscope. In 1845 Johannes Müller, the great pioneer of marine biology, conceived the idea of condensing into a small volume of water the forms which would be found in a very great area. This resulted in the invention of the "Müller Net," a small gauze net which is drawn through the water, entangling in its meshes the very minute and delicate organisms. For a long time Müller and his students pursued the study of marine forms, and at length came the discovery that the marine fauna and flora was directly comparable to the terrestrial.

Yet little is known of the laws of the distribution of marine life. The laws of the distribution of the terrestrial fauna and flora have been formulated for animals in the classical works of Wallace and for plants by Griesbach. The famous *Challenger* expedition (1873–1876), under the direction of Sir Wyville Thompson and Dr. John Murray, has given us the largest conception of the wealth of marine life, and has laid the foundations for the study of the marine forms both at the surface and in the depths of the ocean. Dr. Murray in his preliminary report called particular attention to the enormous wealth of organic life not only at the surface, but also many hundred fathoms below. He says that when living forms were scarce on the surface the tow net usually disclosed very numerous forms below, even to a depth of 1000 fathoms or more. In the North Pacific Ocean, the discovery was made that zones of definite depth are characterized by animals and plants peculiar to them. The tow nets sunk to 500, 1000, or 2000 fathoms brought up forms never found within 100 fathoms of the surface. The animals characteristic of these different depths are, for the most part, of the class of Radiolarians, those microscopic organisms whose silicous skeletons form much of the soft ooze which carpets the bottom of the deep sea. Prof. Haeckel, by study of this material, was led, in his monumental work on the Radiolaria, which forms a part of the "Report of the Challenger," to the recognition of three groups, (*a*) pelagic, swimming at the surface of the calm sea; (*b*) zonary, swimming in definite zones of depth (to a depth of more than 20,000 feet); (*c*) profound (or abyssal) animals swimming immediately over the bottom of the deep sea. In general the different characteristic forms correspond to the different zones (up to 27,000 feet).

The existence of this intermediate pelagic fauna was called in question by Alexander Agassiz, on the ground of the liability of error in using the ordinary open net instead of one which could be closed at a definite depth and then drawn up; and more particularly upon the ground of his own experiments made in 1878 on the *Blake* expedition. He believes that the great bulk of the ocean contains no organic life at all, that the surface fauna of the sea is limited to a relatively thin layer, and that there is no intermediate layer, so to speak, of animal life between the fauna of the bottom of the deep sea and of the surface.

Agassiz's results are contradicted by those of Chierchia on the Italian corvette *Vettor Pisani*. With the closable net invented by Palumko he brought up an astonishing quantity and variety of forms of life from different depths, even up to 4000 metres. Prof. Carl Chun, with an improved closable net, studied the marine fauna and flora of the Gulf of Naples. He formulates his results as follows: (1) That part of the Mediterranean investigated shows a rich pelagic life even to a depth of 1400 metres, as well as at the surface. (2) Pelagic animals, which during the winter and spring appear at the surface, at the beginning of summer seek the depths. (3) At greater depths pelagic animals occur, which hitherto have seldom or not at all been observed at the surface. (4) A number of pelagic animals during the summer remain at the surface and never go into the depths. From his observations upon the vertical distribution of marine life he was led to remark that the surface fauna was apparently only the advance guard of the vast army below. His conclusions were confirmed by observations made during a trip to the Canary Islands, and agree with those made by Prof. Haeckel twenty years before.

Prof. Hensen, of Kiel, has for several years past been studying the phenomena of pelagic life with a view of ascertaining its relations to the fisheries question. He has proposed the term Plankton (from πλάνομαι, to wander) to designate this world of marine life. Prof. Haeckel agrees with this and adds Planktology, that branch of biology which deals with the study of the Plankton. Prof. Hensen hopes to gain valuable information upon the phenomena of marine life by a careful mathematical estimation of the number of individuals in a given bulk of water. Presumably from this and other data some knowledge may be gained of the quantity of life which any definite area of the sea is capable of sustaining.

Prof. Ernst Haeckel, of Jena, has lately published an admirable *résumé* of our knowledge of pelagic life, and has made a very distinct advance by formulating some of the laws which govern its distribution. He has probably done more than any one man to advance our knowledge on this line. Ever since 1854, when, as he tells us, he accompanied the great Johannes Müller to Heligoland and was there introduced by his master to the marine wonderland, he has almost continuously pursued the study of the Plankton. He believes that aquatic life in its broadest features shows conditions of distribution similar to those of terrestrial life, and that we may for the former as well as for the latter distinguish five great geographical provinces, each represented by characteristic forms of animals and plants. (1) the Arctic Ocean; (2) the Atlantic; (3) the Indian; (4) the Pacific; (5) the Antarctic.

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[1] Reprinted from the *American Naturalist* for October, 1892.

All aquatic organic forms fall into two great divisions. (1) Those which live free in the water, either swimming actively or passively floating at the mercy of currents and winds. These compose the Plankton. The Plankton thus includes the widest range of organic size and form, from the minutest microscopic organisms to the gigantic cetaceans. (2) Those forms which live upon the sea bottom, either fixed or creeping about. To these the term Benthos (*τό βένθος*, the bottom of the ocean) is applied. The variety of forms living near the shore is known to vary with the depth, while the forms characteristic of the comparatively shallow waters of the coasts are widely different from those which inhabit the bottom of the deep sea.

The number and the kind of forms composing the Plankton are found to differ with the quality of the water, *i.e.* fresh or salt. In the ocean there is a marked difference which is conditioned by the distance from the shores, either of continents or islands. There are many species of animals, particularly certain cœlenterates, echinoderms, and worms, which pass only part of their life as free-swimming animals; for the remainder, they are bottom dwellers. Such species are not usually found far from the coast, and hence the true oceanic Plankton is made up of forms which pass their entire life as free-swimming organisms. By the presence or absence of these bottom-dwelling species the Planktologist can determine approximately the region where the forms were captured.

A mere list of the genera, not to mention the species, of plants and animals up to the present found to take part in the constitution of the Plankton would be very formidable. The range in size is enormous; from the exceedingly minute unicellular algæ $\frac{1}{25000}$ of an inch in diameter to the huge bulk of many fishes and cetaceans. The microscopic forms constitute the fundamental food supply in the cycle of marine life. They are capable of exceedingly rapid multiplication, and furnish nourishment for the myriads of large animals, which in time are preyed upon by the still higher forms. The inconceivable number of individuals of the smaller species is demonstrated by Prof. Hensen's determination of the number of individuals in about two cubic yards of Baltic Sea water. This was found to contain 5,700,000 distinct organisms; of these only about 150,000 were visible to the unaided eye. But very often microscopic forms become so numerous as to form a slime upon the surface of the water for a considerable area. Ships frequently sail for miles through water coloured by these microscopic organisms, *e.g.*, the so-called "black water" of the Arctic and Antarctic Seas, is a slime of diatoms, which serve as food for the shoals of minute crustacea and mollusca (Pteropods, sea butterflies, and Cephalopods, squid, cuttlefish) upon which the walrus and whales feed. In the warm regions the inconceivably enormous quantity of diatoms are replaced by another kind of algæ, the Oscillatoriæ, which often for an area many miles in extent colour the sea a dark red or yellowish brown. The Red Sea received its name from the abundance of one of these algæ, *Trichodesmium erythræum*, which, according to Ehrenberg, coloured the water along the shore a blood-red. In the warm region also are found the huge floating banks of Sargassum, or gulfweed, forming the so-called Sargasso Seas of the Atlantic and Pacific Oceans. These areas are found to have a marine fauna and flora peculiar to themselves, but approximating in character to that of the coast waters.

The simplest forms of animal life of the Plankton belong to the groups of Infusoria and Rhizopods; to the latter belong those minute animals, the Foraminifera and Radiolarians, which occur in such enormous quantities that their calcareous and siliceous shells form the "deep sea ooze" which carpets the bottom of the deep sea. It is the shells of these animals, too, which have built the vast chalk beds in various parts of the world. Among the multicellular animals which take a prominent part in this marine world are many species of medusæ (jelly fish) and the closely related Siphonophores, of which the beautiful Portuguese man-o'-war is the most familiar representative. The class of worms is represented by many free-swimming species; but in the number of individuals it is far surpassed by the molluscs, chiefly represented by the squids, the pearly and paper nautilus, and the huge cuttlefish, and by the minute and delicately beautiful sea butterflies (Pteropods), which occur in vast schools in the polar seas. Often, too, in very considerable number are found the free-swimming larvæ of Echinoderms, as also many worm larvæ, which, like the former, pass their adult life upon the bottom. Every haul of the gauze net is certain to contain some representatives of the great class of Crustacea, often great numbers of species, as well as of individuals. In distribution these seem to be subject to pretty definite laws, and a careful study of the phenomena would be of great interest. There are found also certain Tunicates, a group interesting because many investigators believe that here we find the transition from the invertebrate ancestor to the higher plane of life of which man is at present the highest representative. ... ...

The vertebrates of the Plankton embrace the great group of fishes, and in addition the marine birds, the seals and walrus, and finally the cetaceans. In this connection, too, the enormous number of fish eggs floating at the surface of the ocean, as well as the transparent, newly-hatched fry must be mentioned. Prof. Hensen hopes to get an idea of the approximate number of fish of a given species in a certain area, computing the number of eggs and fry of that species within that area.

The phenomenon of marine phosphorescence is very widely known with admiration and wonder. Its cause is chiefly or solely bound up with organic life. The majority of pelagic animals display the phosphorescent light in different degrees. In some the entire living animal is brightly luminous; in other the light is limited to special organs. But much of the phosphorescence of the ocean appears to be caused by the fragments of dead organisms, and is connected with the presence of bacteria.

Since many chlorophyll-bearing organisms are found at depths unpenetrated by sunlight, it has been suggested that the light necessary for their growth is furnished by the phosphorescent organisms.

The composition of the Plankton is exceedingly irregular, both in qualitative and in quantitative relations; its distribution in the ocean is also very irregular, both in time and in place. The variations occur near the shore as well as far out at sea. Very often the greater part of the mass of Plankton is made up of organisms belonging to a single group. Sometimes unicellular algæ make up nearly the whole bulk, at another medusæ, siphonophores or ctenophores; indeed, almost any group of marine organisms may occur in such quantities as to compose more than one-half of the total bulk of the Plankton, at that time and place. The fundamental causes of variation in the quantity and quality of the Plankton appears to be conditioned by time, climate, and currents.

Temporal Differences.—For a satisfactory determination of these more complete observations are needed. Reliable data can be furnished by the observations at the numerous marine laboratories and zoological stations now springing up in different parts of the world. The causes which underlie these yearly, monthly, daily, and hourly variations are manifold; in part meteorological, in part biological. They are comparable to the corresponding oscillations of the terrestrial fauna and flora, and depend on the one side upon climatic and meteorological conditions, and on the other upon the varying mode of life, particularly upon conditions of reproduction and development. Just as the annual development of most land plants is bound up with a definite time of year, as the time of budding and leafing, of blooming and fruiting, have in the "struggle for existence" become adapted to the meteorological conditions, the time of year, and other conditions of existence, so too the annual development of most marine animals is conditioned by definite habits, which have become fixed by heredity. The yearly variations may be compared to the good and bad fruit years. This yearly variation has been noted by many observers in case of many marine animals. Our attention is often called to an example of it in the unusual abundance or scarcity of the catch of certain food fishes.

Many marine animals, particularly certain medusæ, siphonophores, ctenophores, molluscs, and tunicates, are found at the surface only periodically, in one or a few months of the year. This is probably dependent upon conditions of reproduction and development, as well as upon the temperature of the season. The daily variations are conditioned by the weather, and particularly by the wind and rain. A shower will very quickly reduce the specific gravity of the surface water and thus drive the surface-dwelling animals below. Many animals rise to the surface only at a definite time of day, some in the morning, others at noon, and yet others only towards evening.

Climatic Difference.—Prof. Haeckel thinks that the quantity of the Plankton is very little dependent upon the climatic difference of the zones, but that the quality is greatly so, and indeed in this way, that the number of component species diminishes from the equator to the poles. These conditions, he believes, are directly referable to the influence of the sun, "the omnipotent creator," whose more direct rays bring about an acceleration in the processes which make up the cycle of life. As this is true of the terrestrial fauna and flora so it is true of the marine.

Currentic Differences.—Conspicuous differences are also brought about by the numberless currents, great and small, by the little-known deep sea oceanic currents as well as by the better-known great surface currents, the Gulf Stream, the Falkland Stream, the Guinea Stream and others. These currents play a great *rôle* in the distribution of many forms of life. More local influences are exerted by the small currents whose causes are found in the climatic and geographical conditions of the adjacent coast. The relations of Plankton life to currents is little known, and needs investigation, but first a better knowledge of the currents themselves is necessary.

Almost every one who has seen the surface of the ocean in a calm has noticed the glassy areas of irregular shape. These are found on the high seas as well as in sheltered bays and harbours, and are of very special interest to the student of marine life. So far as made out they are extremely irregular in time and place of appearance, and the conditions governing them have not been carefully studied. They are in a measure influenced by winds and currents, by the ebb and flow of the tide. Here, into a limited space, are crowded great numbers of organic forms; this space is readily distinguished from the surrounding water in which there is comparatively little life. These phenomena have been noticed by seafaring men and have many different names in different countries.

A word in conclusion as to the bearing and importance of the Plankton in human economy in the near future. When Malthus promulgated his famous doctrine he failed to consider the final element which enters into the problem of human population, the human mind. The ingenuity of the human mind has brought about a decreased efficiency in the natural checks to undue increase, and thus an artificial increase in the food supply is rendered necessary for the crowding population. This food supply is now mainly derived from the cultivation of the land. A still further increase of population will necessitate a levy upon marine life. As soon as man to any great degree becomes a factor in the Plankton conditions by drawing from it large quantities of food, particularly in the form of mature animals, the equilibrium of oceanic life will be disturbed, and must be adjusted by artificial means. But further, a study of the phenomena of marine life shows that the water as well as the land, through cultivation, is capable of producing a greatly increased food supply for man. The necessity of cultivating the marine resources is even now apparent, and many governments have already begun to cope with the question by the establishment of commissions of fisheries Of these commissions that of the United States stands in the front rank by virtue of its positive results. But in the near future individual attention must be turned to supplementing the terrestrial resources, the wheat fields, the cattle and sheep ranches, by an increasing utilization and development of the possibilities of marine farming; by fish propagation, by plantations of oysters, clams, quahaugs and scallops, by raising herds of lobsters and crabs. Improved breed of fish, of lobsters will result. The possibilities are well-nigh limitless; and by cultivation of the sea and sea bottom, as well as of the land, man will postpone indefinitely the fulfilment of the Malthusian prophecy.

But conditioning all advance in the possibilities of marine cultivation is the knowledge of the Plankton, of its distribution, and of the fundamental basis of marine life the microscopic marine organisms in the ocean.

GEORGE W. FIELD.

OPTICAL PROJECTION.[1]

THE intention of this lecture is to give a general survey of the subject of Optical Projection, which now takes its position in science, and to present examples of what may be done by this method. It would be difficult to determine which subject claims a first place. Some scientists say the microscope should have the preference, while others take a different view. For my own part, I think the microscope and polariscope stand foremost, on account of the facility with which these branches of science may be pursued for the benefit of a large number, without multiplying expensive apparatus; also because of the convenience in saving the eyes from undue strain. Indeed, to many persons, looking at objects in the table microscope is little short of a painful operation, and consequently the study of small objects becomes to them impossible. The projection method immediately brings the required relief.

For general instruction, projection methods are invaluable, such as, for instance, showing diagrams, photographs, and other slides, upon the screen; as well as for spectrum analysis. In fact, the subjects which can be illustrated by means of optical projection are innumerable; but time will allow me to present only a few examples, and I trust that, when I approach the end of my lecture, my view of the importance of this subject will be held in equal estimation by you.

Probably the only people in the world that benefit by the experience of their predecessors are those who pursue the study of science. They are free from the accusation of robbing the brains of other men, when they take up methods or apparatus already known and improve upon them or employ them for their own work. In such cases, however, it is always understood that honour should be given where honour is due, and accordingly I have no wish to represent to you any piece of apparatus as of my own devising, when in reality it belongs to another.

Few men have had a larger experience, and attained greater success in optical projection, than has Mr. Lewis Wright, who has embodied in his most recent forms of apparatus all that was good in designs existing until his time. I have, therefore, started from his models, making such modifications as I thought to be desirable. Mr. Wright does not appear—if I may say so—to have had much experience with the electric arc light as a radiant, and I found, at a very early stage, that great difficulties had to be encountered when this light was used, chiefly because the radiant approaches more nearly to what theory requires. That which was easy with the lime-light became almost impossible with the arc lamp, and these difficulties had to be conquered.

Many scientific men are dissatisfied with the projection microscope, on the ground that very high magnification does not give that resolution and that sharpness which is found in the usual methods of observation. This want I fully admit. At the same time it is scarcely right to condemn a particular method because you try to apply it to an unsuitable purpose. Hundreds of thousands of subjects may be shown with the projection microscope with far greater profit to the student than was possible in the old way. The very fact that the professor can place his pointer upon any part of the picture on the screen is invaluable to the students. I shall, therefore, attempt to show you only a series of microscopical subjects suitable for projection, and shall not employ very high magnification.

In regard to some substances very high powers may be used with advantage, but much time would be lost in getting them into the field and focussing them upon the screen. These, consequently, I omit, so that a large number of subjects may be illustrated.

It is fair to state that most of the apparatus used to-night has been constructed by Messrs. Newton, of Fleet-street, and the luminous pointer by Messrs. Steward, of the Strand. The arc lamp is a Brockie's projector. Messrs. Baker, Watson, and others have also come to my assistance.

I will first show, on the screen, a picture of the lantern carrying its various apparatus; and then a few systems of lenses, which may be employed for the projection microscope, as well as a diagram of the microscope itself.

Sub-stage condensers and objectives are, as a rule, made to suit the table microscope. When projecting, by means of an objective alone, in consequence of the screen distance being very great—or, in other words, the microscope tube being exceedingly long as compared with the table instrument—the objective has to be approached very close to the slide; in fact, with the higher powers, closer than the cover-glass will allow. This close working distance renders necessary special sub-stage condensers, and in many cases a special one is required for every screen distance with each objective. This requisite would seem to be a complete stumbling-block to microscope projection work. With the lime-light the difficulty does not enter in the same degree as with the arc light, and as we are now dealing with the latter, further reference need not be made to the oxy-hydrogen light. There are two ways of surmounting the difficulty; one by the use of plano-concave lenses, introduced in such a way as to be equivalent to greatly lengthening the focus of the objective on the screen side, while it enables, as a consequence, the objective to be slightly further removed from the slide, *i.e.*, giving what is termed a greater working distance. The objection to this method is that, even when these plano-concave lenses are corrected, the result, though greatly improved, is not perfect. The second way, which is a perfect one, is that of introducing an eye-piece. In both these methods, that the best results may be obtained, the objective is made to occupy a position not very different from that which it would do if employed on the table microscope.

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[1] Friday evening discourse delivered by Sir David Salomons at the Royal Institution, on February 26.

In the eye-piece method almost the exact conditions can be complied with for which the objective was made. I propose, therefore, to show the subjects by the eye-piece method. The only objectives which will be used are: (1) Zeiss's 35 millimetre projection objective, with a sub-stage condenser, 4 inches focal length. placed a considerable distance from the slide; (2) Newton's 1-inch projection objective, the sub-stage condenser as in the first case; and (3) Zeiss's ¼-inch achromatic objective, the sub.stage condenser being Prof. Abbé's three-lens condenser with the front lens removed. In all three cases the eye-pieces used are Zeiss Huyghens No. 2 and No. 3.

In each instance I will mention the magnification in diameters, as well as the number of times when reckoned by area, for the appreciation of those who estimate by area; and I will also give the size to which a penny postage stamp would be increased, supposing it to be made of india.rubber, and stretchable to any extent in all directions. In presenting these figures I do not pretend that they are absolutely correct, but as they have been ascertained under conditions similar to those now existing the errors will not be very great.

In consequence of the field not being quite flat, and the sections having a certain thickness, although extremely thin in most cases, the whole of the object cannot be in focus upon the screen at the same time. By shifting the focussing screw slightly all parts may be brought into focus successively. So-called greater depth of focus is obtained by using an increased working distance; and for projection work over-correction for flatness can alone give a sharp picture all over with very considerable depth of focus; the difficulty of over-correction being that, unless extreme care is taken, certain forms of distortion may be introduced. By stopping down the objective greater flatness of field may be secured, but at the expense of light. There is thus a choice of difficulties, and the least one should be taken.

Turning now to the polariscope. Polarized light teaches us a great deal concerning the structure of matter; it is also a means of confirming the undulatory theory of light. This subject is so large that no attempt can be made to give even a general idea of the field it covers, and the experiments, which will be shown in the polariscope, may be taken simply as a few illustrations of the subject and nothing more; but they will, at any rate, be suggestive of the large field to which this method of analysis can be applied. A vast amount of mathematical proof can be illustrated graphically by various experiments with polarized light. I will show on the screen a diagram of the polariscope. (Shown.)

With reference to showing the spectrum. The method of projecting a spectrum, I think, is new, as I have not seen it described anywhere. It gives practically a direct spectrum with an ordinary prism, without turning the lantern round to an angle with the screen; and here is a diagram of the method.

The details of the apparatus, as well as those of the methods of working, I have modified in almost every instance, for five reasons:—(1) That more certain results may be ensured; (2) that rapidity may be obtained; (3) that only one operator may be needed; (4) that, as far as possible, all parts of the apparatus may be interchangeable; and (5) that loose screws and pieces may be dispensed with.

There were then shown by projection a number of slides illustrating various microscopic optical systems, and a number of microscopic slides, followed by a series of general polariscopic projections, some of them to illustrate the strains existing in many forms of matter; also a spectrum by a carbon disulphide prism, in conjunction with a reflecting prism and with a mirror, which, apart from any other result, demonstrates that the loss of light with a reflecting prism is less than with an ordinary glass mirror. Slides and other projections were also thrown upon the screen.

The details are as follows:—

The Microscope.—Screen distance, 21 feet. First 35 millimetres Zeiss projection objective, 4-inch sub-stage condenser, Zeiss Huyghens eye-piece 2; 500 diameters = 250,000 times = penny stamp stretched to cover about 147 square yards. Subjects shown: proboscis of blowfly; permanent molar displacing milk-tooth (kitten); human scalp, vertical; human scalp, surface; fossil ammonites and belemnite. Second, 1-inch Newton's projection objective, 4-inch sub-stage condenser, Zeiss Huyghen's eye-piece 2; 1,000 diameters = 1,000,000 times = stamp stretched to about 588 square yards. Objects shown: proboscis of blowfly; foot of a caterpillar; section of human skin, showing the sweat ducts; phylloxera vastatrix of the vine. Third, 1-inch Newton's projection objective, 4-inch sub-stage condenser, Zeiss Huyghens eye-piece 3; 1,300 diameters = 1,690,000 times = stamp stretched to about one-fifth of an acre. Slides shown: proboscis of blow-fly; wings of bee (showing hooklets and ridge); sting of bee (showing the two stings, sheath, and poison-sack); sting of wasp (showing same as last slide); eye of beetle (showing the facets). Fourth, ¼-inch Zeiss's achromatic objective; Abbé's 3-lens sub-stage condenser, with top lens removed; Zeiss Huyghens eye-piece 3; 4,500 diameters = 20,250,000 times = stamp extended to nearly 2½ acres. Slides shown: proboscis of blow-fly; hair of reindeer (showing cell structure); hair of Indian bat (showing the peculiar funnel-like structure); sting of bee (showing the barbs); foot of spider; stage of the micrometer (the closest lines ruled to thousandth of an inch, which measure 4½ inches apart under this magnification); a wave length $\frac{1}{40000}$ inch, therefore, on screen measures about ⅑-inch.

The Polariscope.—Shown with parallel light: plain glass; glass under pressure; chilled glass (round, oval, and waved peripheries); Prince Rupert's drop (broken in the field); horn; selenites (over-lapped); butterfly (selenite); bunch of grapes (selenite); bi-quartz, with ¼-wave plate (the ¼-wave plate in this experiment produces the same effect upon the bi-quartz as if a column, 20 centimetres long, of a 7½ per cent. solution of cane sugar were placed between the polarizing nicol and the bi-quartz. The analyser has to be rotated about 10°); a piece of sapphire to show asterism. Shown with convergent light; hemitrope (cut in a plane, not at right angles to the axis); ruby; topaz; grape sugar (diabetic); cane sugar; quartz; superposed right and left-handed quartz (spirals); calcite and phenakite superposed (showing transition from negative to positive crystal, passing through the apopholite stage).

The Solidiscope.—New form of apparatus for showing solids, and consisting of two reflecting prisms and suitable projecting lenses. With this instrument were shown:—Barton's button, the works of a watch, a coin.

Spectrum Analysis.—Spectrum thrown by means of a disulphide prism combined with a reflecting prism; the result being that a good spectrum is thrown upon the screen direct without turning the lantern. There were shown:—The spectrum; absorption bands of chlorophyll, &c.; effects produced by passing the light through coloured gelatine films.

Projection of Slides.—Decomposition of water; expansion of a wire by means of heat; combination of colours to form white light; various diagrams, coloured photographs of a workshop, &c. As an extra experiment there was shown, in the polariscope, with a convergent light, Mitscherlisch's experiment (illustrating the changes which take place in a selenite under the influence of heat).

There are but few who would disagree with me in the opinion that the microscopic world, as regards its design and its molecular structure, is quite as wonderful as the great works aroun us seen with the unaided eye. A magnifying glass of low powe opens up a world far larger than that which we are accustome to see. At the present time, even with the most perfect apparatus that exist, only a small portion of the universe is known t us.

Scientific study should be pursued by all in a greater or less degree. It teaches more important lessons than the most impressive discourse ever preached. During the investigation of what is generally termed the invisible world, men should at time pause to reflect, and ask themselves such questions as these: What is the meaning of, and to what end is, creation? Is it all mere chance? Were such wonderful designs and properties created at the beginning? Was there in matter at the beginning an inherent, or implanted, power of development? Simple as these questions may seem, man in the flesh will never be able to find the true answers. The extraordinary design and structure which have existed in the unseen world for millions of years, or possibly in all past time, and even at the present day known to so few, demonstrate at least that the great Power has bestowed the same care upon what appear to us the most insignificant portions of creation, as upon what we think are the greatest works in the universe. These silent sermons must surely influence the mind, and set it thinking of the supernatural and of our duties during life.

It may now with truth be said that science gives us means, such as never before existed, of appreciating the greatness of the Supreme Spirit, by enabling us to read fresh chapters in the book of nature.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Prof. Darwin has been appointed to represent the University at the approaching tercentenary of Galileo's appointment to a chair in the University of Padua. The celebration will take place in Padua at the beginning of December.

Prof. Green, of Oxford, is appointed an Elector to the Harkness University Scholarship in Geology in the place of the late Mr. T. Roberts, assistant to the Woodwardian Professor.

The discussion in the Senate of the proposal to found a mechanical sciences tripos for engineering students was unexpectedly favourable, in marked contrast to the reception accorded to former schemes. Prof. Ewing is to be congratulated on the skill with which the new plan has been framed, and the success with which he has met and conciliated the original opposition of the more mathematical members of the Senate. The grants for the approval of the plan have been sanctioned by the Council, and it is not likely that they will now be opposed. Some fifteen students are already at work in the engineering laboratary in preparation for the new tripos, which bids fair to take a good place among the honours schools, and cannot fail to stimulate the growth of the engineering department under its present energetic head.

DUBLIN.—At the meeting of Council of the Royal College of Science, Dublin, held on the 5th inst., a letter was read from H.M. Commissioners for the Exhibition of 1851, announcing that they had been pleased to place at the disposal of the College a science scholarship of the annual value of £150 for the year 1893. These scholarships are specially instituted for the encouragement of scientific research and are tenable for two years, and one of them has already been nominated to by the Council of the College for the year 1891-92.

SCIENTIFIC SERIALS.

American Journal of Science, October.—On a colour system, by O. N. Rood.—An ottrelite-bearing phase of a metamorphic conglomerate in the Green Mountains, by C. L. Whittle.—The age-coating in incandescent lamps, by E. L. Nichols. The diminution of efficiency in incandescent lamps is due to three causes, viz., loss of vacuum, increase of resistance due to the the disintegration of the filament, and finally the deposition of disintegrated carbon upon the inner surface of the lamp-bulb. This deposition gives rise to what is called the age-coating. It appears that the rate of deposit of the coating in incandescent lamp-bulbs is greatest in the early part of the life of the lamp. For example, in the case of a lamp which lasted 800 hours, more than half the coating was deposited during the first 200 hours. The loss of brightness due to the absorbing power of the age-coating is a variable part of the total loss, being greatest in lamps of high initial efficiency. The coating does not appreciably modify the character of the light transmitted, as shown by a series of photo-spectroscopic measurements. The distribution of the coating within the bulb is nearly uniform. No marked difference between treated and untreated filaments appears to exist as regards the coating produced from them. It has been pointed out, however, that in the case of lamps exhausted without the aid of mercury the age-coating is scarcely perceptible.—Mica-peridotite from Kentucky, by J. S. Diller.—Glaciation in the Finger Lake region of New York, by D. F. Lincoln.—Certain points in the interaction of potassium permanganate and sulphuric acid, by F. A. Gooch and E. W. Danner. When these two bodies are brought into solution together there is developed a tendency towards reduction on the part of the permanganate, which is the greater as the strength of the acid is increased, as the temperature is raised, and as the duration of the action is extended. At first, the oxygen lost to the permanganate is li[illegible] in the later stages manganese is precipitated [illegible] of a higher oxide or retained in solution in the form of a higher sulphate.—Crystallography of the cæsium-mercuric halides, by S. L. Penfield.—Silver hemisulphate, by M. C. Lea.—Restorations of Claosaurus and Ceratosaurus, by O. C Marsh.—Restoration of *Mastodon Americanus* (Cuvier), by the same.

THE number of the *Nuovo Giornale Botanico Italiano* for October is entirely occupied by the continuation of Sig. Nicotia's Statistics of the Flora of Sicily.

American Journal of Mathematics, vol. xiv., No. 3 (Baltimore, the John Hopkins Press, 1892).—The title of Prof. Cayley's communication, "Corrected Seminomiant tables for the Weights 11 and 12" (pp. 195–200) explains itself. It contains a better form of tables, which were given in a previous volume (vii., pp. 59–73). Weierstrass, in his memoir "Zur Funktionenlehre," called attention to certain functions, which offer special singularities. "Au lieu de présenter un nombre fini ou infini de points singuliers essentiels *isolés* elles offrent des lignes singulières essentielles ou même des *espaces lacunaires* à l'intérieur desquels elles cessent d'exister."—By request of Mr. Hermit, M. H. Poincaré discusses the subject in an article "Sur les fonctions à espaces lacunaires" (pp. 201-221).—J. C. Field, writes on "Transformation of a System of Independent Variables" (pp. 230–236).—Mansfield Merriman discusses "The deduction of final formulas for the Algebraic Solution of the Quartic Equation" (pp. 237–245), and L. S. Hulburt in remarks on "A class of new theorems on the number and arrangement of the real branches of plane Algebraic Curves" (pp. 246–250), follows up recent work, in the same direction, by Messrs. Harnack and Hilbert."—"The Symbolic notation of Aronhold and Clebsch" (pp. 251–261) has for its object the exposition of this notation, "so well adapted to the expression of functional invariants," in an English form. The same writer, W. F. Osgood, also contributes a note on "the System of two simultaneous Ternary Quadratic forms" (pp. 262-273). This, likewise, is a simplification for the benefit of English readers. It contains an account of Gordon's method, and employs the notation of the preceding article.—H. S. White communicates notes "on generating systems of Ternary and Quaternary Linear transformations" (pp. 274–282), and "a Symbolic demonstration of Hilbert's method for deriving Invariants and Covariants of given Ternary forms" (pp. 283–290). This latter paper also uses the symbolic notation of Aronhold and Clebsch in a simplified statement of recent results developed in Hilbert's notable paper "Ueber die Theorie der Algebräischen Formen" (Math.-Aca., vol. 36, pp. 524–6). The only paper, in the present number, which was read before the New York Mathematical Society is one by the President, Emory McClintock, "On the Computation of Covariants by Transvection" (pp. 222–229).

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 17.—M. Duchartre in the chair.—On Mr. Barnard's discovery of the fifth satellite of Jupiter, by M. F. Tisserand.—On the application of certain methods of successive approximation to ordinary differential equations, by M. Emile Picard.—On a reaction alleged to be peculiar to spermine, by M. Duclaux.—Observations of three new small planets discovered at the Nice observatory by means of photography, by M. Charlois; report by M. Perrotin (see Astronomical Column).—On the coexistence of dielectric power and electrolytic conductivity, by M. E. Bouty. A vindication of priority.—On the polarization of light of various colours by the atmosphere, by M. N. Piltschikoff. There is a well-marked difference between the intensity of polarization of blue light and that of red in the atmosphere The intensities are measured by means of a Cornu photo-polarimeter. The eye-end of this instrument is covered with a cobalt glass, the quantity of polarized light from the chosen point in the sky is measured, the blue glass replaced by a ruby glass, and the determination repeated for the latter. Generally, the intensity of polarization for blue light is sensibly greater than that of the red. This is not favourable to Lallemand's theory of the blue colour of the sky as a phenomenon of fluorescence. The difference of polarization is, however, not constant, but depends upon the direction of the wind. A series of observations made at Kharkoff between April and September, 1892, show a maximum difference with a south-easterly wind, diminishing symmetrically on both sides, and even becoming negative at W. N. W. The amount of polarization of the blue shows the opposite distribution, so that w[illegible]tion of the atmosphere rises or falls, the effect is gre[illegible] less refrangible radiations than in the others. There is also a notable relation between polarization and atmospheric moisture. The S.E. brings the greatest amount of precipitation, the northerly winds the least. It is also probable that dust and dry fogs exert a considerable influence, as shown by the circumstance that the greatest differences have been obtained in high winds, when the whole town was covered with dust.—On a new way of preparing acetylene, by M. L. Maquenne (see Notes).—On the analysis of mixtures of ammonia and methylamines, by M. H. Quantin.—On the nervous tissues of some invertebrates, by M. A. B. Griffiths.—Examination of some rocks collected by Prince Henry of Orléans on the lower Black River in Tonkin, by M. Stanislas Meunier.—Note on the miocene formations of western Algeria, by M. Jules Welsch. The miocene formations occur in normal succession near Hamman Riva, where they rest on the Cretaceous. It appears certain that the last upheaval of the Atlas did not take place at the end of the Helvetian epoch (middle miocene), as hitherto believed. It was post-Tortonian, and took place at the end of the upper miocene. For the formations of Gontas, Ben Chicao, Mascara, &c., are Tortonian; they are within the block of the Atlas Mountains, and have been lifted to heights of 800, 1000, and even 1700 metres. This result tends to confirm the general idea worked out within the last few years that the zones of folding are nearer the equator in proportion as they are more recent.

AMSTERDAM.

Royal Academy of Sciences, September 24, Prof. Van de Sande Bakhuysen in the chair.—Mr. H. A. Lorentz dealt with the reflection of light by moving bodies. In a former paper ("Arch. néerlandaises," t. xxv. p. 363) the author considered the propagation of light through a ponderable dielectric which has a movement of translation, but leaves at rest the inclosed ether. The equations then arrived at may be written in the form—

$$\text{div. } D = 0. \quad \text{div. } H = 0,$$

$$\text{curl } E = -\dot{H}, \text{ curl}\left[H + \frac{1}{v^2}\text{ vect. }(Ep)\right]4\pi\dot{D},$$

$$4\pi V^2 D = n^2 E + \text{vect. }(Hp),$$

the vectors H, D, E, and p representing the magnetic force, the dielectric displacement, the electric force, and the velocity of the ponderable matter. The signs "div." and "curl" have the same meaning as in Heaviside's formulæ (*Phil. Mag.*, 5th ser. vol. xxii. p. 118), and Vect. (Ep) indicates the vector product. Finally, V is the velocity of light in vacuum, and n the index of refraction. At the boundary of two media, possessing a common translation, there will be continuity of the normal components of D and H, and of the tangential components of E and $\left[H + \frac{1}{v^2}\text{ vect.}(Ep)\right]$. If i and r are the angles of incidence and refraction for the relative rays ("Arch. neérlandaises," t. 21, pp. 129–134), Fresnel's expressions for the amplitude of the reflected ray—

$$\frac{\sin(i-r)}{\sin(i+r)} \text{ and } \frac{tg(i-r)}{tg(i+r)}$$

have to be multiplied by

$$1 - \frac{2p_1 \cos i}{Vn_1},$$

where n_1 relates to the first medium, and p_1 is the velocity, in the direction of the normal, with which the reflecting surface recedes. This result may be shown to be consistent with the conservation of energy, provided that the pressure exerted, according to Maxwell, by the vibratory motion, be taken into account.—M. van Bemmelen made a second communication on the existence of the crystalline hydrate of Fe_2O_3. He obtained the ferrite of sodium ($Fe_2O_3Na_2O$) in different crystal forms. Under certain circumstances this form was a hexagonal plate. These crystals could be metamorphosed by the action of water in the hydrate of Fe_2O_3, without loss of their optical properties.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Student's Hand-book of Physical Geology: A. J. Jukes-Browne, 2nd Edition (Bell).—The Beauties of Nature: Sir John Lubbock (Macmillan).—Notes on Qualitative Chemical Analysis: P. L. N. Nayudu (Madras, Chetty).—Amherst Trees: J. E. Humphrey (Amherst, Mass., Carpenter).—Magnetical and Meteorological Observations made at the Government Observatory, Bombay, 1890 (Bombay).—Explosives and their Power: M. Berthelot, translated by C. N. Hake and W. Macnab (Murray).—Domestic Electric Lighting, treated from the Consumer's Point of View: E. C. de Segundo (Alabaster).—Introduction to Physiological Psychology: Dr. T. Ziehen, translated by C. C. van Liew and Dr. O. Beyer (Sonnenschein).—Notes by a Naturalist: H. N. Moseley, New Edition (Murray).—The Science and Practice of Lighting: W. H. Y. Webber (W. King).—Commercial Organic Analysis, vol. 3, Part 2, 2nd Edition: A. H. Allen (Churchill).—Comité International des Poids et Mesures. Procès Verbaux des Séances de 1891 (Paris, Gauthier-Villars).—The Reliquary, vol. 6, New Series (Bemrose).—Vergleichende Morphologie der Pilze: Dr. F. v. Tavel (Jena, Fischer).—Beiträge zur Biologie und Anatomie der Lianen: Erster Theil; Beiträge zur Biologie der Lianen: Dr. H. Schenck (Jena, Fischer).—Dissections Illustrated, Part 1, the Upper Limb: C. J. Brodie (Whittaker).—Science Instruments (Newcastle-on-Tyne, Brady and Martin).—Treatise on Thermodynamics: P Alexander (Longmans).—Vegetable Wasps and Plant-Worms: Dr. M. C. Cooke (S.P.C.K.).—Text-book of Petrology: Dr. F. H. Hatch, 2nd Edition (Sonnenschein).—Meteorological Service Report, 1888: C. Carpmael (Ottawa. Dawson),

PAMPHLETS.—The Inaugural Robert Boyle Lecture: Sir H. W. Acland (Frowde).—Astronomical Observations made at the University Observatory, Oxford, No. 4, Researches in Stellar Parallax by the Aid of Photography, Part 2: Prof. Pritchard (Oxford, Clarendon Press).

SERIALS.—Records of the Australian Museum, vol. 2, Nos. 2 and 3 (Sydney).—Journal of State Medicine, vol. 1, No. 2 (Griffin).—Journal of the Chemical Society, October (Gurney and Jackson).—Zeitschrift für Wissenschaftliche Zoologie, 54 Band, 3 Heft (Williams and Norgate).—Journal of the Royal Microscopical Society, October (Williams and Norgate).—Journal of Anatomy and Physiology, vol. 27, New Series, vol. 7, Part 1 (Griffin).

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